The Software Package

# Marine Training Software Part 1 - 8

**UNITEST Marine Training Software Part 1 - 8** are software packages consisting of the several, independent, educational modules.

**The following modules are included:**

- Air Conditioning Plant 3D
- Auxiliary Steam Boiler Installation
- Biological Sewage Treatment Plant
- C.P.Propeller Installation
- Comb. Oil Fired and Exhaust Gas Boiler
- Diesel Engine Generators
- Diesel Engines
- EcoStream
- Emergency Power Plant 3D
- Electric Power Plant
- Fixed Delivery Pump Steering Gear Inst.
- Freshwater Generator
- Freshwater Generator 3D
- Freshwater Generator 3D AQUA Type
- Fuel Conditioning Module 3D
- Fuel Oil Treatment Plant
- Gas Turbine
- Hydrophore Installation
- Hydrophore Installation 3D
- Marine Compressors
- Marine Diesel Engine Monitoring Systems
- Marine Heat Exchangers
- Marine Hydraulic Machinery
- Marine Pumps
- Oily Water Separator
- R.C.S. for MAN B&W LMC engines
- R.C.S. for SULZER RTA Engines
- Refrigeration Plant
- Refrigeration Plant 3D
- Reverse Osmosis Desalination System
- Rotary Vane Steering Gear
- S-type Separation System
- Variable Delivery Pump Steering Gear Installation

**The basic tasks for CBT – interactive programs are:**

- familiarisation with individual auxiliary shipboard system or equipment,
- developing operation skills,
- train and refresh emergency procedures (react to emergency situation),
- combine simulations with multimedia techniques like diagrams, pictures, sound,
- English language skills improvement,
- preparation for pre-promotion assessment of competency,
- intensified trainee's activity during educational process,
- to make the assessment process of trainee more objective,
- to make the learning process shorter with simultaneous increase in quality.

The above mentioned training simulators are interactive i.e. they enable the realistic presentation of the marine power plant equipment functioning. The simulators are equipped with control panels and system installation diagrams. The control panels contain switches, pressure gauges as well as control and alarm lamps. The control panel and the main switchboard were intentionally designed to be as close as possible to the real equipment design.

Some programmes offer the possibility to realise regulations of the system parameters. In case of faulty operations the simulators will react identically as it happens during normal operations.

All operations on the PC screen (for example: valve opening, pump starting) are effectuated by mouse-clicking. The automatic valves are controlled by control panel. Graphic symbol symbols which are used in programs are described in the legend. Most of the programs are sound-generated. An appropriate mathematical and logical model of an equipment or system ensures that that the program will react during trainee's action exactly as it would react for the real object. In case of faulty operations the program will react identically as it happens during normal operation. Information about the action performed by student is displayed in form of digital or analogue data, colour changes of pipes and sound effect as well.

**Typical UNITEST CBT interactive program contains the following parts:**

System description

This part describes the application, working principles and main components of the installation, together with different kind of graphic presentation (pictures, photos, diagrams etc.).By mouse-clicking on the appropriate field of the installation diagram, the name of the particular part appears.

Operating instruction

This program's part includes a "step by step" detailed description of the preparation for starting the plant, starting the plant, automatic and manual control functioning and stopping the plant procedure. This part presents also diagrams illustrating the consecutive phases of the plant operation.

Test

The test is intended to assess the knowledge gained by the trainee from the two first parts of the program. In this module, the trainee should indicate the correct answer to randomly selected questions. This enables the trainee to effectuate the test various times without having to answer the same questions. At the end of the test the trainee is granted a certain mark indicating the rate of correct answers (each correct answer gives the trainee a result of ten points).

Simulator

In this section of the program, interactive software simulator is applied. The trainee, by mouse clicking, must set the valves on the installation diagram in proper position and start the pump, the compressors etc. by operation of the switches and push- buttons on the panel. The trainee must follow the instructions given in the Operating Instruction. This enables the trainee to apply in practice the theoretical knowledge acquired according to the Operating Instruction. The trainee is confronted with real life reactions of the installation.

**The CBT – interactive programs application possibilities are:**

- lectures
- exercises and seminars
- laboratory
- examination centres
- vocational training centres
- individual self-training
- application on-the job training

The programmes enable also the simulation of faulty operation that may not always be realised under real conditions.

Generally, optimum results in the use of computer based simulation of an interactive character, are achieved when each individual student is able to work on one PC station. The use of computer based simulation increases in a considerable way the effects of the educational process and reduces the cost of training and the increases the effectiveness of marine engineering educational scheme.

# AIR CONDITIONING PLANT

## 1. Introduction

The AIR CONDITIONING PLANT simulator is intended for teaching the basic principles of how to operate a typical marine air conditioning plant.

The simulator consists of the following elements:

1. Air Handling Unit (AHU)
2. Refrigerating Condensing Unit
3. Steam valves block
4. Control panel
5. Diagram

Fig .1. Air Conditioning Plant

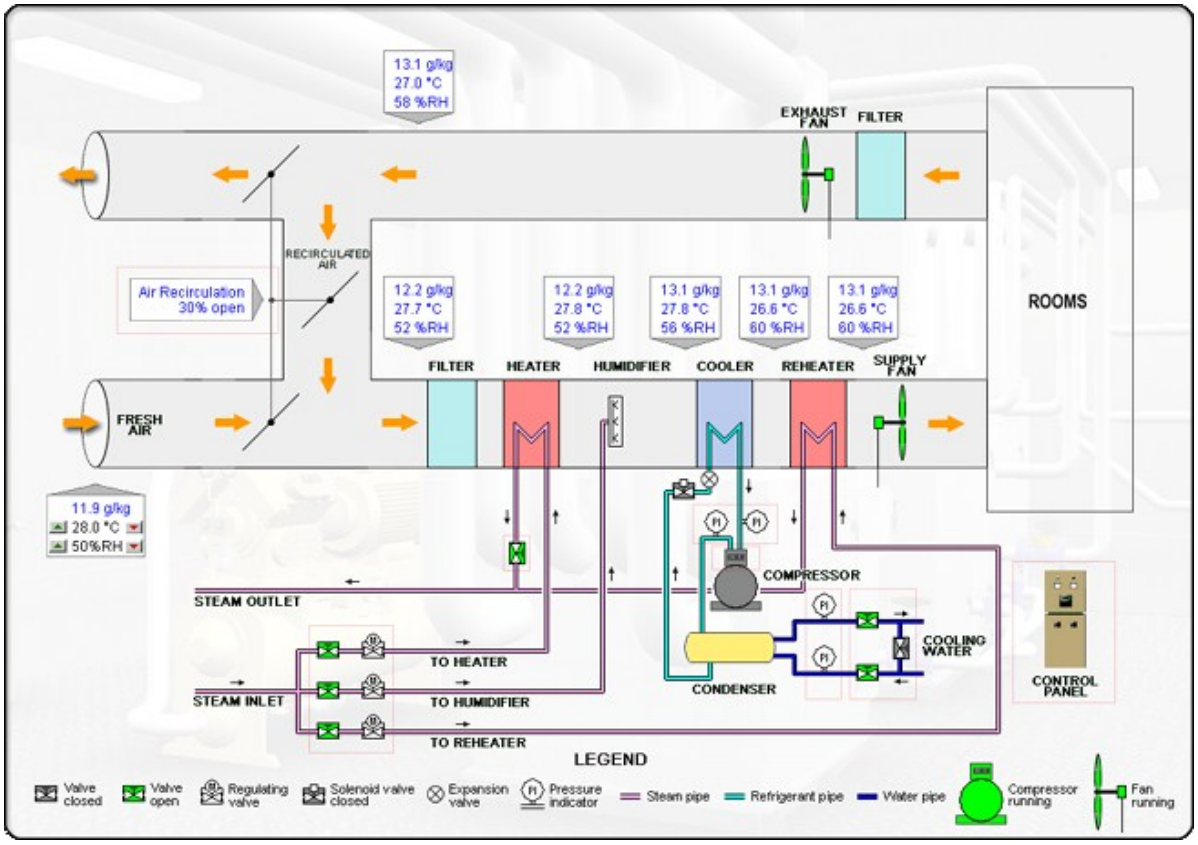



Fig. 2. Simulator diagram

The simulator diagram shows the basic status and configuration of AHU.
The following parameters of the air are presented:

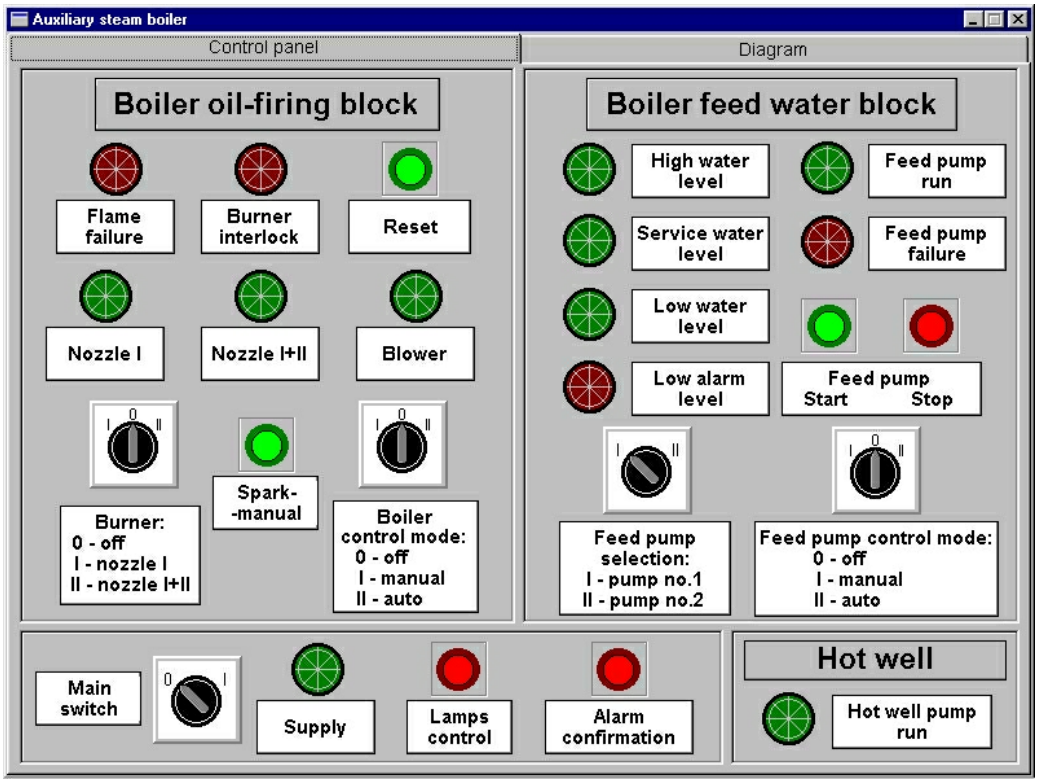
- temperature [oC]
- absolute humidity [g/kg]
- relative humidity [%]

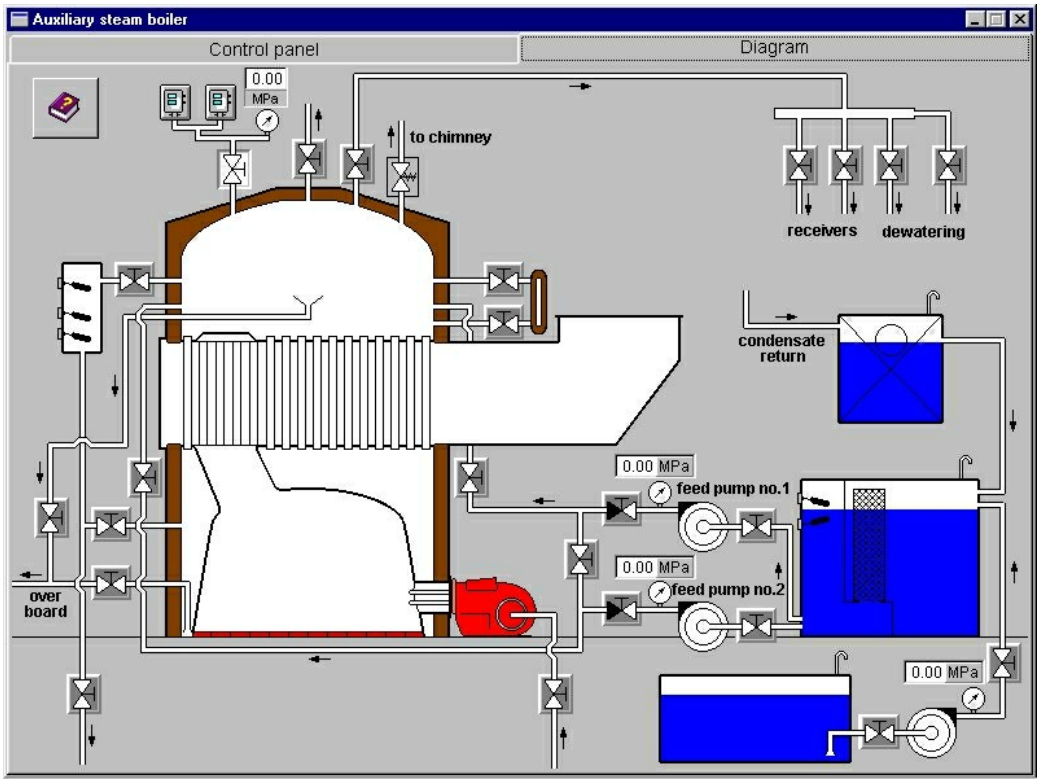
# AUXILIARY STEAM BOILER

The **AUXILIARY STEAM BOILER** training simulator is designated for learning the essential principles of the marine steam boiler plant maintenance. The program is based on typical marine oil-fired auxiliary boiler – vertical water-tube type.

The program consists of the following three parts:

- Control panel
- Installation diagram
- Fuel nozzle pressure control



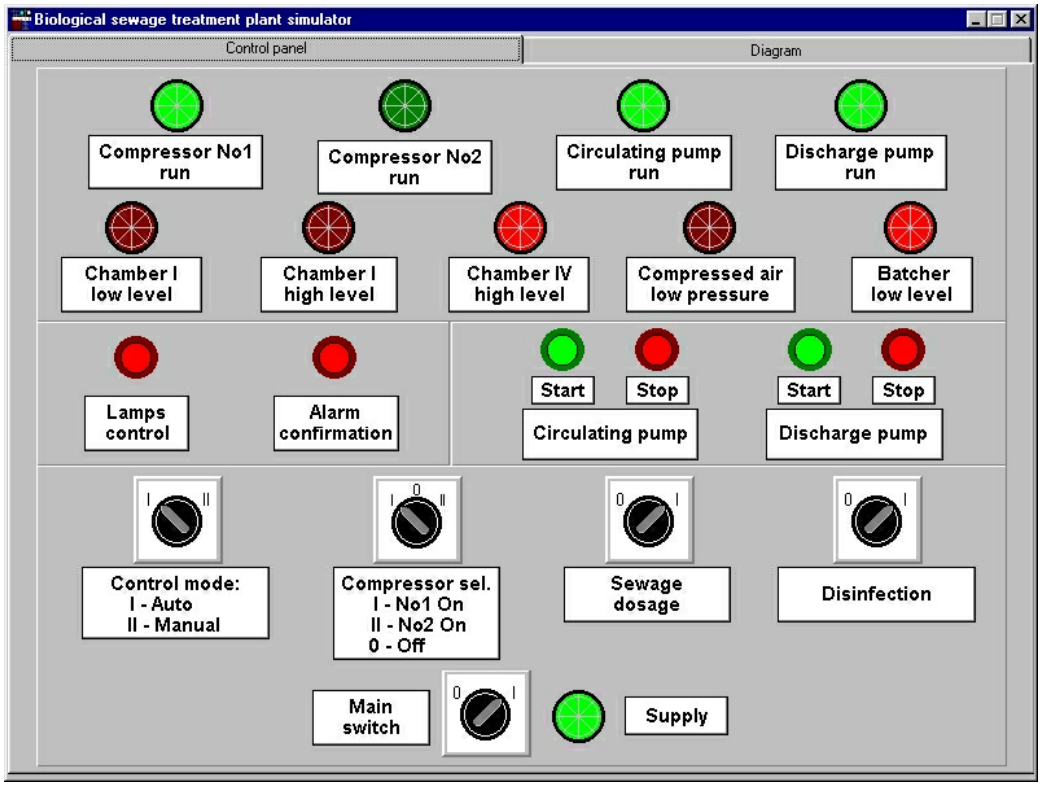

Auxiliary steam boiler
Control panel
Diagram
0.00
MPa
to chimney
receivers
dewatering
condensate
return
0.00 MPa
feed pump no.1
0.00 MPa
feed pump no.2
over
board
0.00 MPa

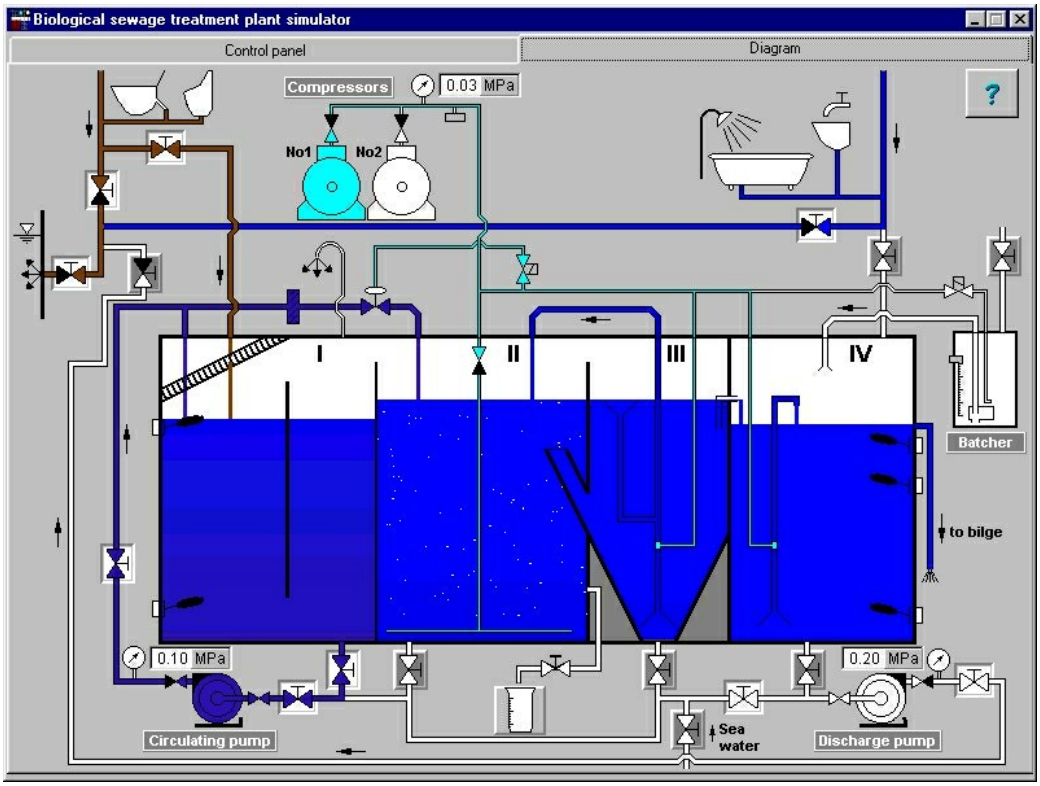
# BIOLOGICAL SEWAGE TREATMENT PLANT

The **BIOLOGICAL SEWAGE TREATMENT PLANT** – training simulator is designated for learning the essential principles of the marine sewage treatment plant maintenance. The program is based on typical marine sewage treatment plants, type LK 30 A, produced by Pomeranian Ship Equipment Works –WARMA – Poland.

The program consists of two parts, as follows:

- control panel
- installation diagram




Biological sewage treatment plant simulator
Control panel
Diagram
Compressors
0.03 MPa
No1
No2
?
I
II
III
IV
Batcher
to bilge
0.10 MPa
0.20 MPa
Circulating pump
Sea water
Discharge pump

# COMBINED OIL FIRED AND EXHAUST GAS BOILER

The educational program **Combined oil fired and exhaust gas boiler** is intended for teaching the basic principles of how to operate a typical combined boiler. The program is based on an installation combine boiler type **AQ-16** produced by **AALBORG Industries Corporation.**

The program consists of two main parts:

- Multimedia presentation
- Simulator

The multimedia presentation part of the program consists of main sections mentioned below:

1. Description of **oil fired and exhaust gas boiler type AQ-16** (introduction on the working principles and basic modules of the typical combined boiler system)

    a) general information and introduction
    b) water level control system
    c) steam-dumping equipment
    d) feed and boiler water
    e) photos

2. Description of **Oil Burner type MS 7 Z**

    a) general information and introduction
    b) Burner equipment (oil burner pump, burner motor, combustion head, ignition electrodes)
    c) Burner management
    d) Working operation of oil burner

3. Operating procedures

    a) Start on diesel oil
    b) Change over to heavy fuel oil
    c) Manual operation of burner

4. Assessment - some questions about the theory and the practice in the skill test

## Oil burner pump

**Oil pump** is a gear-wheel pump provided for a pressure up to 3 MPa. The pump is equipped with a built-in pressure regulator with a quick working valve, which keeps stable the adjusted pressure.

In order to protect the pump against impurities in the oil a filter is also built-in.

**Important**

The suction intake line must be filled with fuel oil prior to start up.

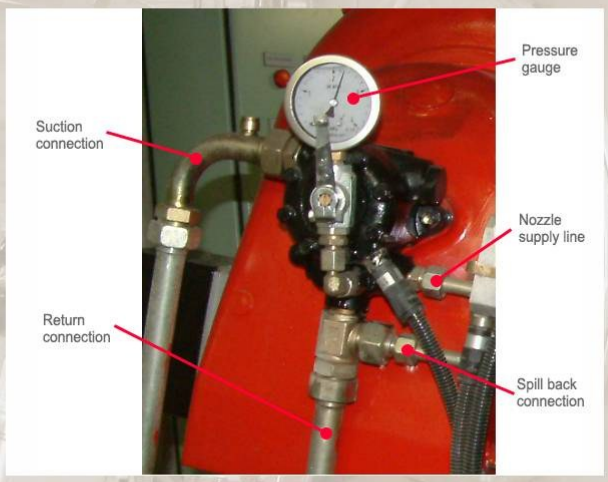


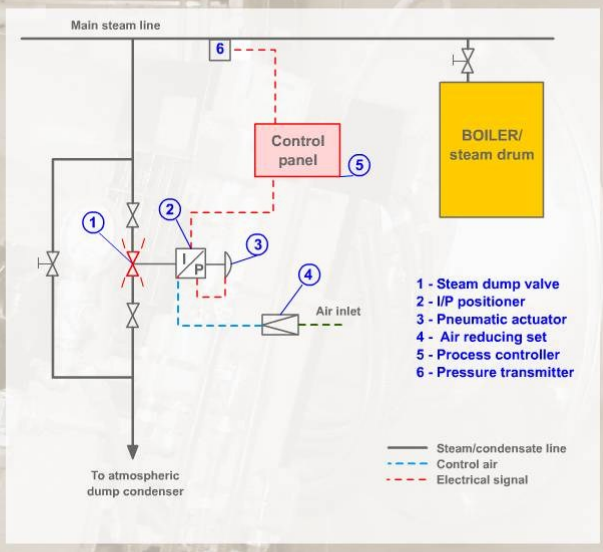

Fig. 4 Burner pump

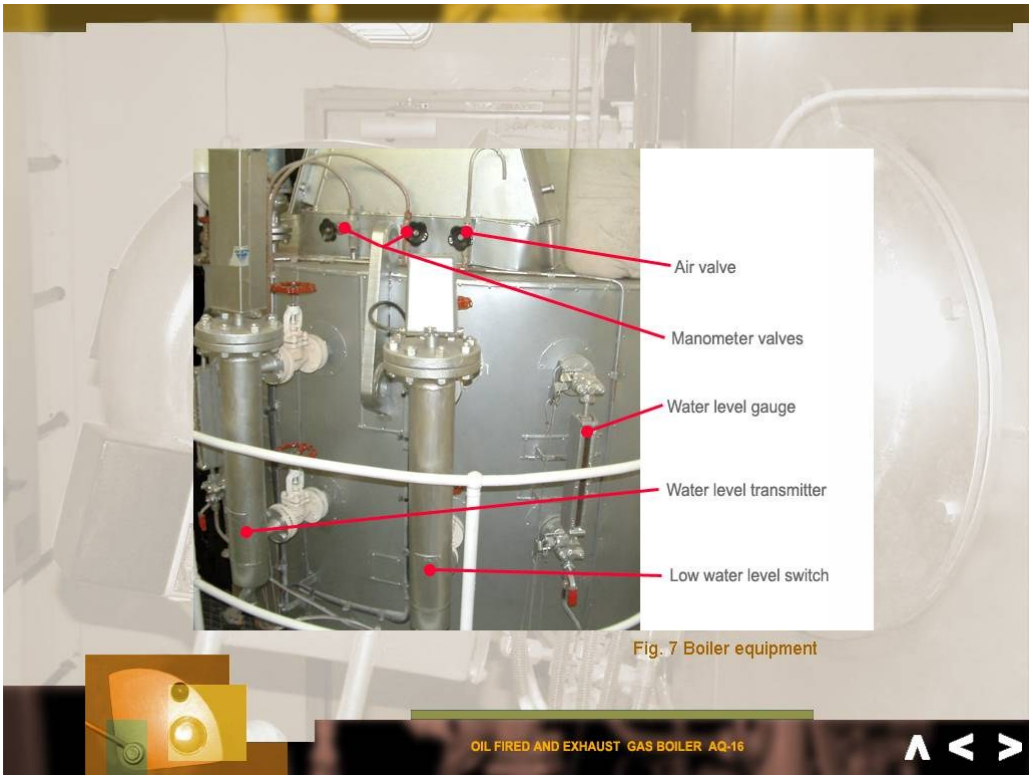


## Steam-dumping equipment

The equipment is working by measuring the steam pressure with a pressure transmitter **(6)**. The transmitter sends an electrical signal to the process controller/local panel **(5)**. In the control system the signal is compared with a pre-set adjustable value.

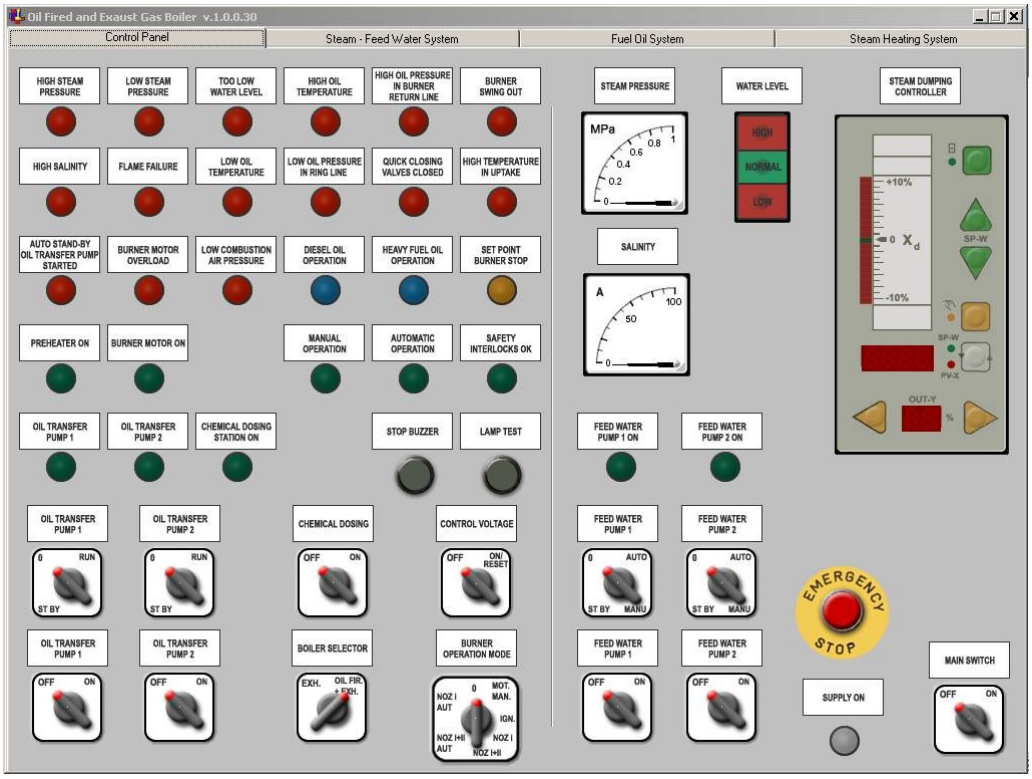
The steam pressure is then regulated when the control system sends an electrical signal to the I/P positioner **(2)**. It converts the signal and via the pneumatic actuator **(3)** controls the position of the steam dump valve **(1)**. The excess steam is directed to the atmospheric dump condenser.

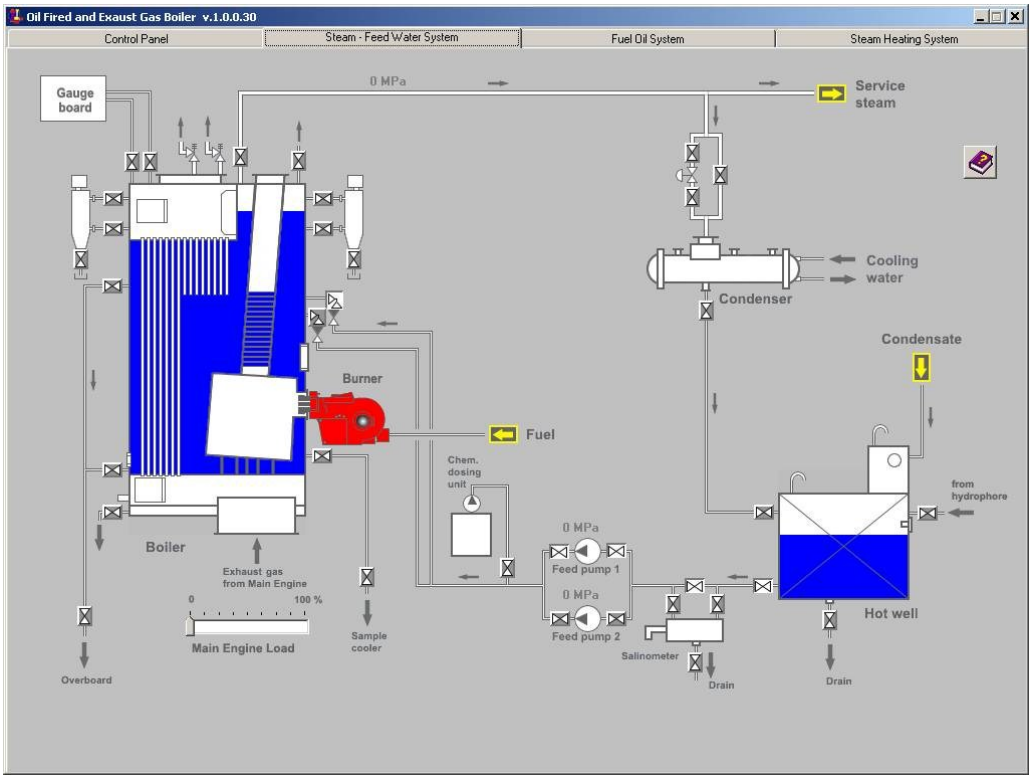


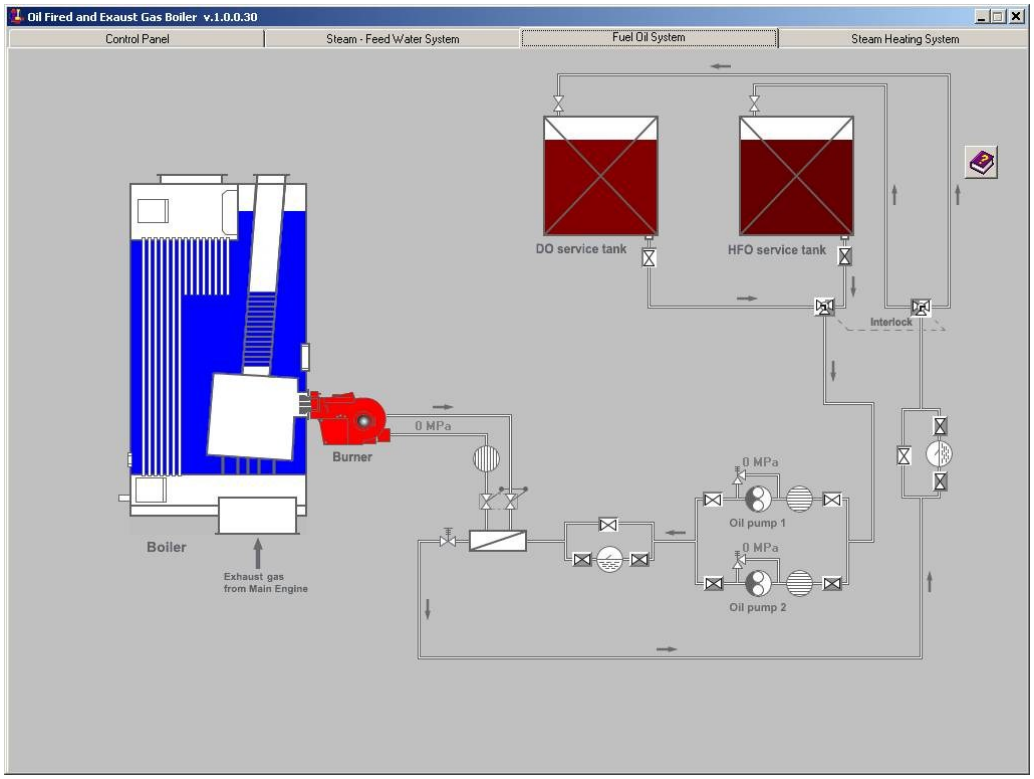


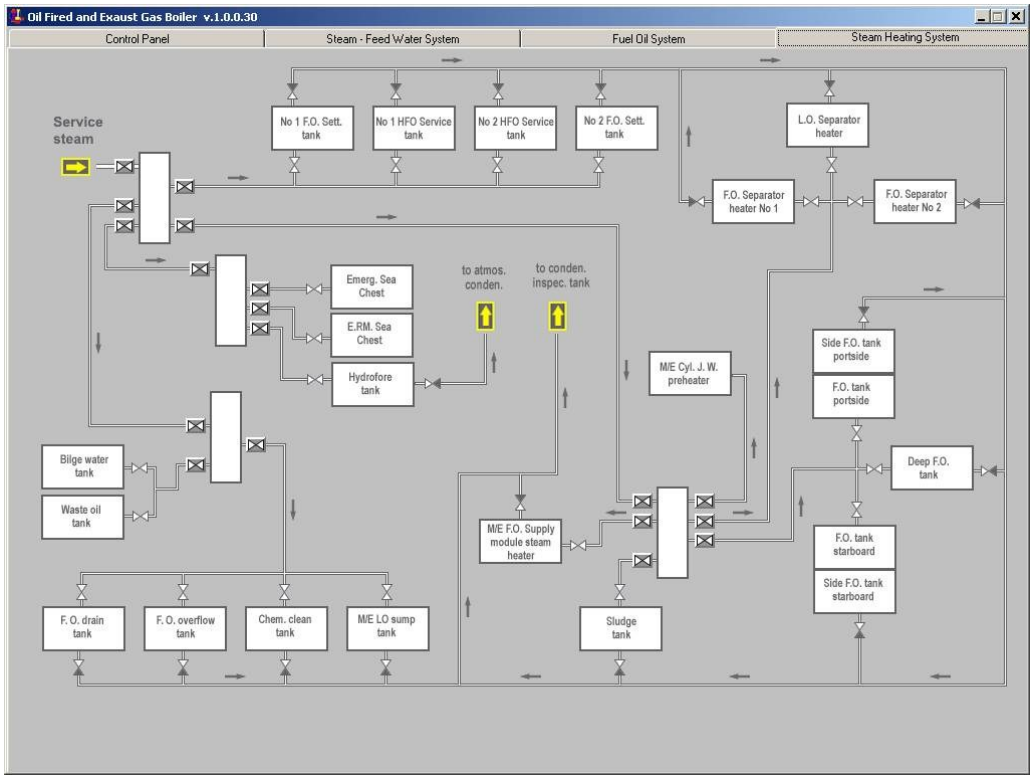

The **simulator program** is interactive i.e. it enable the realistic presentation of the Combined Boiler System functioning. System reaction are identically as it happens during normal operations The simulator consists of the following parts:

- Control Panel
- Steam - Feed Water System
- Fuel Oil System
- Steam Heating System


Oil Fired and Exaust Gas Boiler v.1.0.0.30
Control Panel
Steam - Feed Water System
Fuel Oil System
Steam Heating System
HIGH STEAM PRESSURE
LOW STEAM PRESSURE
TOO LOW WATER LEVEL
HIGH OIL TEMPERATURE
HIGH OIL PRESSURE IN BURNER RETURN LINE
BURNER SWING OUT
HIGH SALINITY
FLAME FAILURE
LOW OIL TEMPERATURE
LOW OIL PRESSURE IN RING LINE
QUICK CLOSING VALVES CLOSED
HIGH TEMPERATURE IN UPTAKE
AUTO STAND-BY OIL TRANSFER PUMP STARTED
BURNER MOTOR OVERLOAD
LOW COMBUSTION AIR PRESSURE
DIESEL OIL OPERATION
HEAVY FUEL OIL OPERATION
SET POINT BURNER STOP
PREHEATER ON
BURNER MOTOR ON
MANUAL OPERATION
AUTOMATIC OPERATION
SAFETY INTERLOCKS OK
OIL TRANSFER PUMP 1
OIL TRANSFER PUMP 2
CHEMICAL DOSING STATION ON
STOP BUZZER
LAMP TEST
STEAM PRESSURE
WATER LEVEL
STEAM DUMPING CONTROLLER
MPa
SALINITY
HIGH
NORMAL
LOW
FEED WATER PUMP 1 ON
FEED WATER PUMP 2 ON
CHEMICAL DOSING
CONTROL VOLTAGE
BOILER SELECTOR
BURNER OPERATION MODE
EMERGENCY STOP
SUPPLY ON
MAIN SWITCH


Oil Fired and Exaust Gas Boiler v.1.0.0.30
Control Panel
Steam - Feed Water System
Fuel Oil System
Steam Heating System
Gauge board
0 MPa
Service steam
Cooling water
Condenser
Condensate
Burner
Fuel
Chem. dosing unit
Boiler
Exhaust gas from Main Engine
Main Engine Load
Sample cooler
Overboard
Feed pump 1
Feed pump 2
Salinometer
Drain
Hot well
from hydrophore


Oil Fired and Exaust Gas Boiler v.1.0.0.30
Control Panel
Steam - Feed Water System
Fuel Oil System
Steam Heating System
DO service tank
HFO service tank
Interlock
Burner
0 MPa
Boiler
Exhaust gas
from Main Engine
0 MPa
Oil pump 1
0 MPa
Oil pump 2

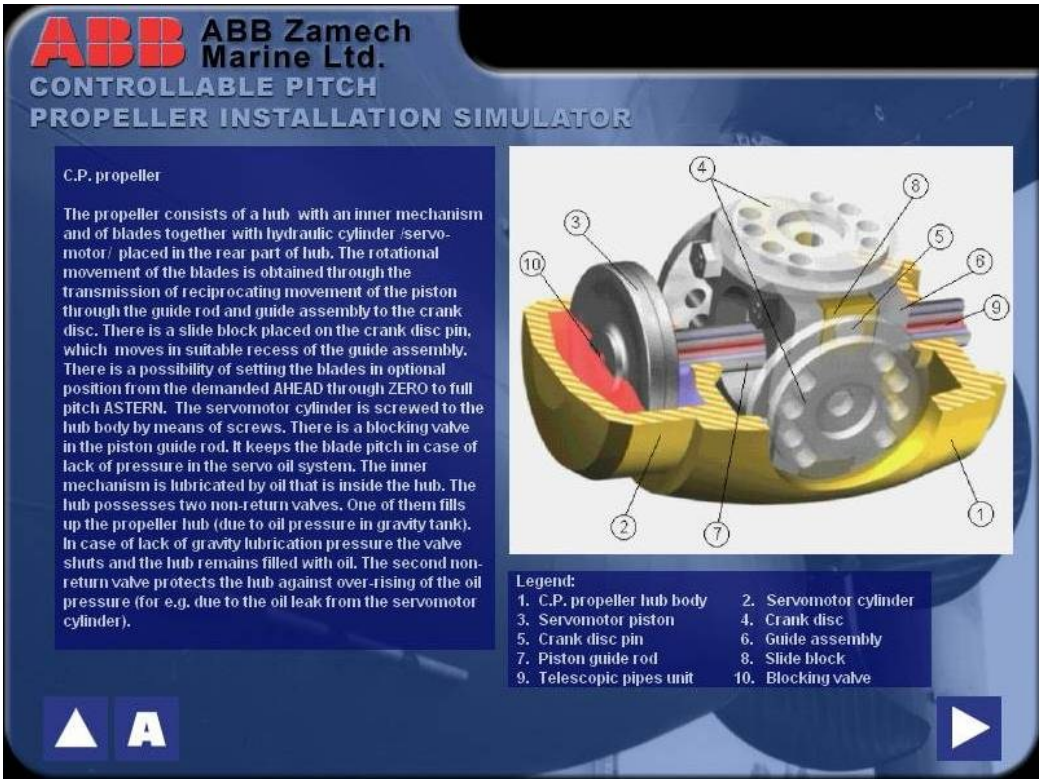

Oil Fired and Exaust Gas Boiler v.1.0.0.30
Control Panel
Steam - Feed Water System
Fuel Oil System
Steam Heating System
Service steam
No 1 F.O. Sett. tank
No 1 HFO Service tank
No 2 HFO Service tank
No 2 F.O. Sett. tank
L.O. Separator heater
F.O. Separator heater No 1
F.O. Separator heater No 2
Emerg. Sea Chest
E.RM. Sea Chest
Hydrofore tank
to atmos. conden.
to conden. inspec. tank
M/E Cyl. J. W. preheater
Side F.O. tank portside
F.O. tank portside
Deep F.O. tank
Bilge water tank
Waste oil tank
M/E F.O. Supply module steam heater
F.O. tank starboard
Side F.O. tank starboard
F. O. drain tank
F. O. overflow tank
Chem. clean tank
M/E LO sump tank
Sludge tank

# CONTROLLABLE PITCH PROPELLER

The educational program CONTROLLABLE PITCH PROPELLER is intended for teaching the basic principles of how to operate a typical C.P. propeller installation, that is being presently used on ships. This simulator is based on the C.P. propeller PH-RK type, produced by ABB Zamech Marine Ltd. in Elbląg, Poland .

The program consists of two main parts:

- Multimedia presentation
- Simulator



The multimedia presentation part of the program consists of main sections mentioned below:

1. Description

    a) general description
    b) main elements description
    c) main elements pictures

2. Operating

    a) CPP operating modes
    b) starting procedure – basic operation
    c) starting procedure – emergency operation in case of control signal from bridge disconnection
    d) starting procedure – emergency operation in case of a failure of main pump aggregates
    e) CPP stopping procedure

3. Test

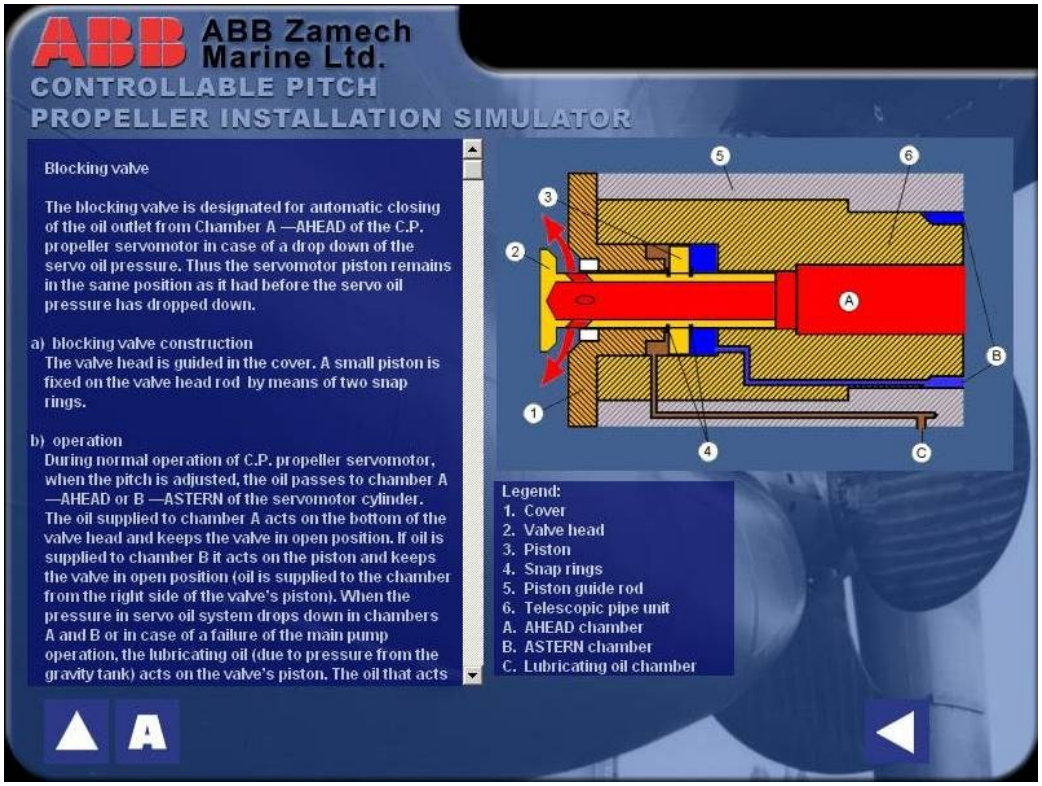


ABB Zamech Marine Ltd.
CONTROLLABLE PITCH
PROPELLER INSTALLATION SIMULATOR
Blocking valve
The blocking valve is designated for automatic closing of the oil outlet from Chamber A —AHEAD of the C.P. propeller servomotor in case of a drop down of the servo oil pressure. Thus the servomotor piston remains in the same position as it had before the servo oil pressure has dropped down.
a) blocking valve construction
The valve head is guided in the cover. A small piston is fixed on the valve head rod by means of two snap rings.
b) operation
During normal operation of C.P. propeller servomotor, when the pitch is adjusted, the oil passes to chamber A —AHEAD or B —ASTERN of the servomotor cylinder. The oil supplied to chamber A acts on the bottom of the valve head and keeps the valve in open position. If oil is supplied to chamber B it acts on the piston and keeps the valve in open position (oil is supplied to the chamber from the right side of the valve's piston). When the pressure in servo oil system drops down in chambers A and B or in case of a failure of the main pump operation, the lubricating oil (due to pressure from the gravity tank) acts on the valve's piston. The oil that acts
1
2
3
4
5
6
A
B
C
Legend:
1. Cover
2. Valve head
3. Piston
4. Snap rings
5. Piston guide rod
6. Telescopic pipe unit
A. AHEAD chamber
B. ASTERN chamber
C. Lubricating oil chamber
A

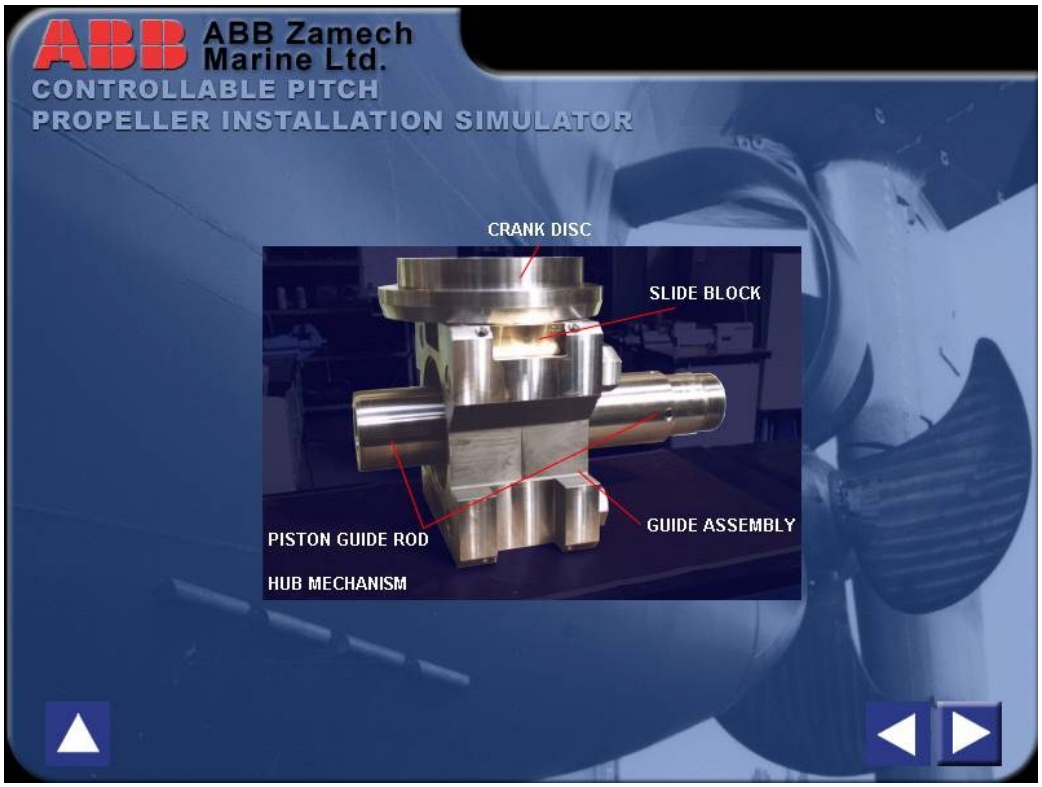
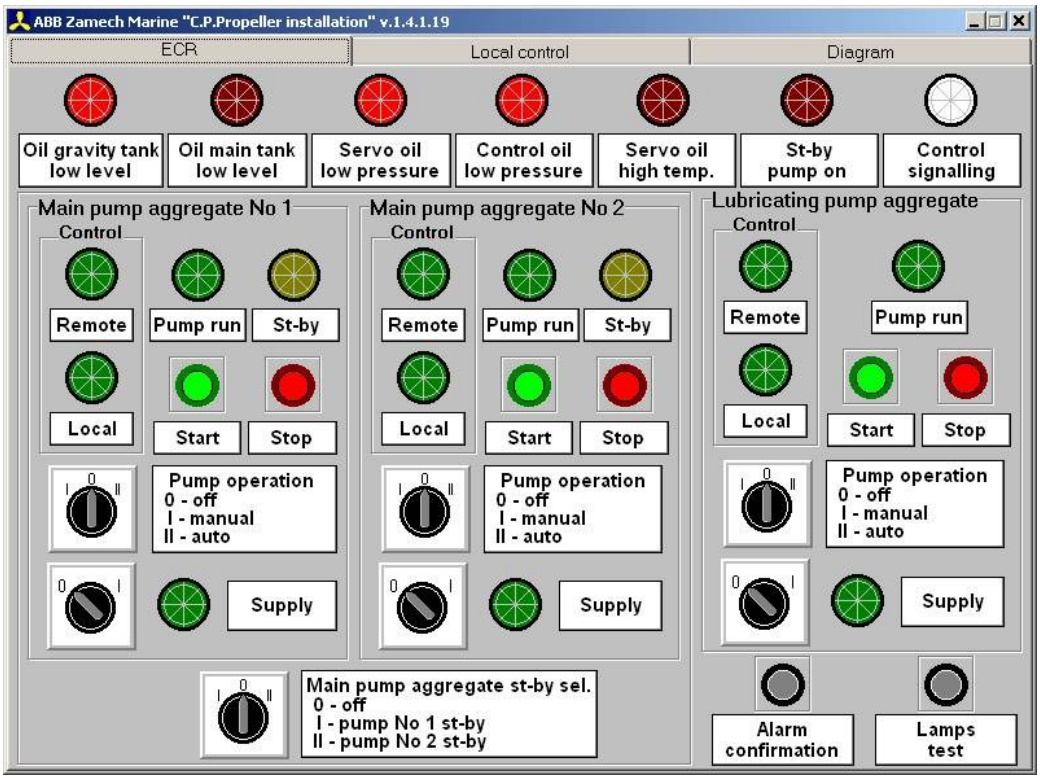


ABB Zamech Marine Ltd.
CONTROLLABLE PITCH
PROPELLER INSTALLATION SIMULATOR
CRANK DISC
SLIDE BLOCK
GUIDE ASSEMBLY
PISTON GUIDE ROD
HUB MECHANISM

The **simulator program** consists of the following parts:

- C.P. Propeller installation diagram
- Pump Aggregates Panel in Engine Control Room (ECR)
- Pump Aggregates Local Control panel



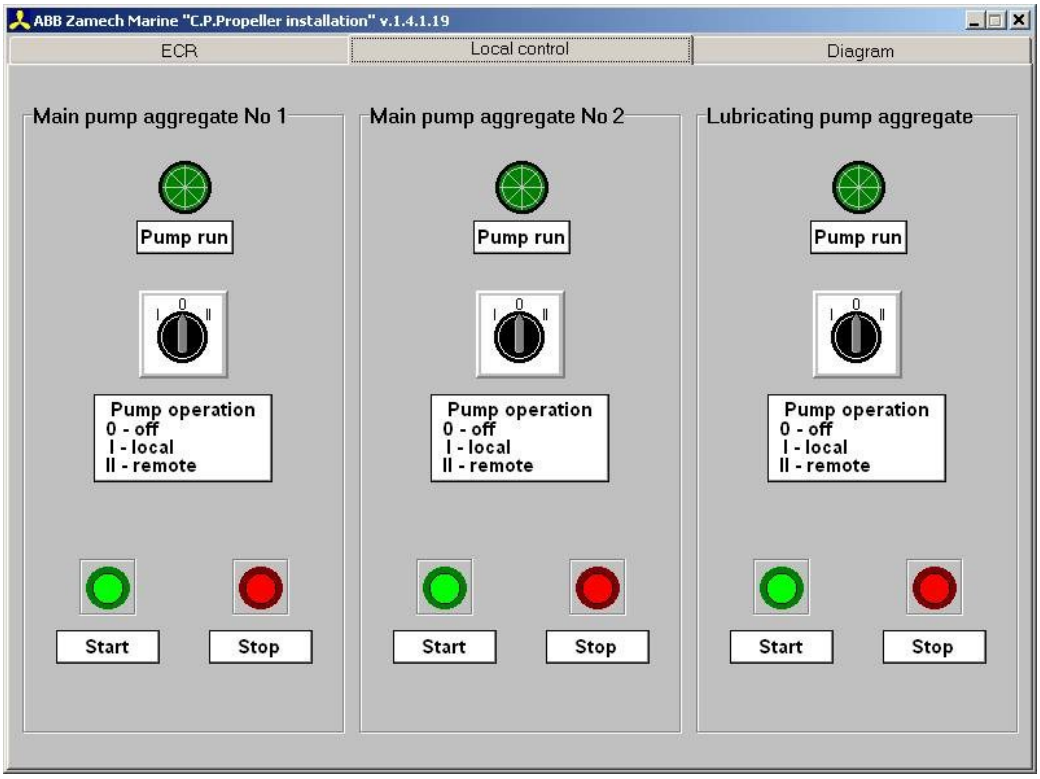


ABB Zamech Marine "C.P.Propeller installation" v.1.4.1.19
ECR
Local control
Diagram
Main pump aggregate No 1
Main pump aggregate No 2
Lubricating pump aggregate
Pump run
Pump operation
0 - off
I - local
II - remote
Start
Stop

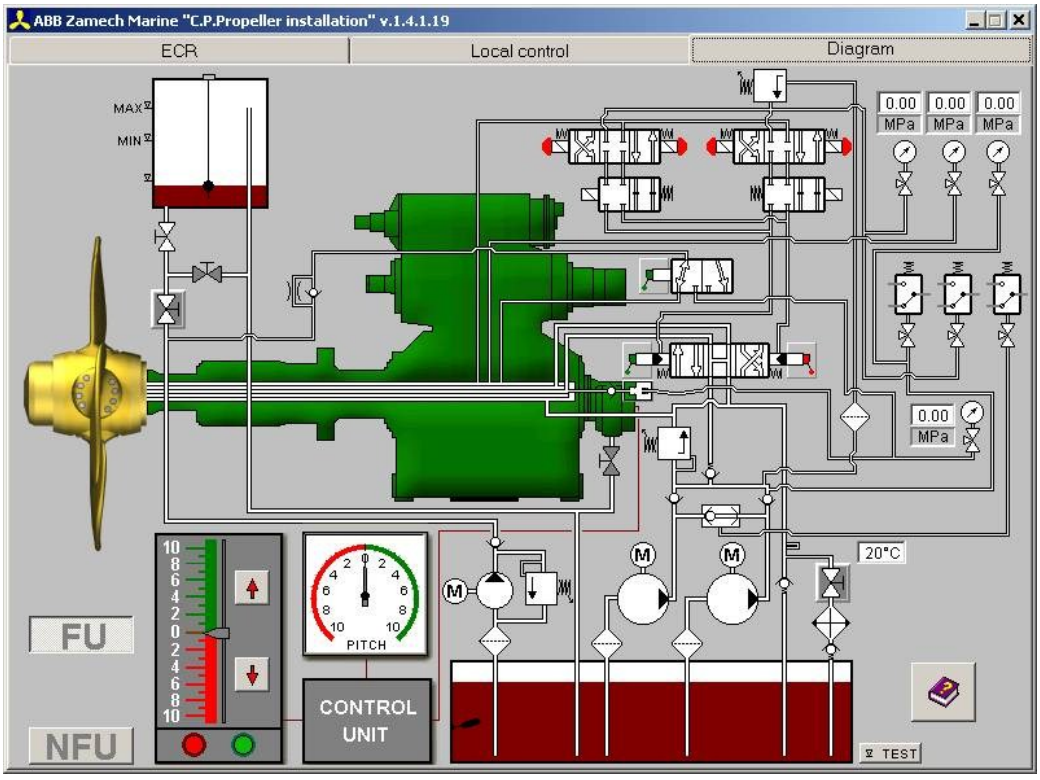
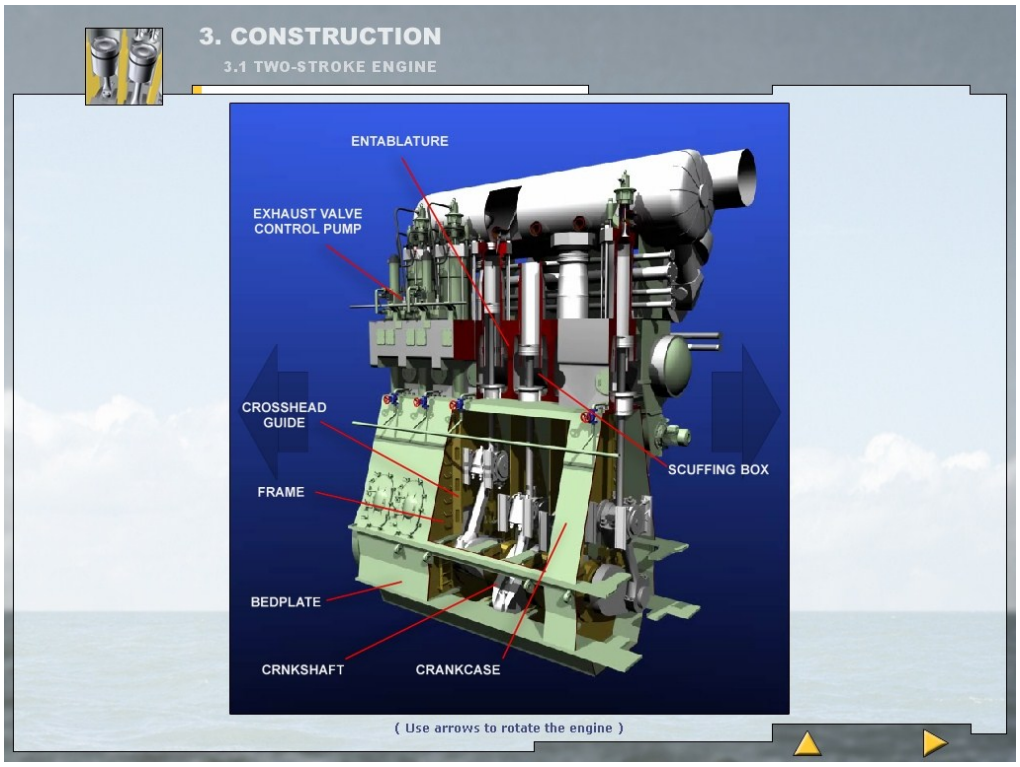


ABB Zamech Marine "C.P.Propeller installation" v.1.4.1.19
ECR
Local control
Diagram
MAX
MIN
0.00
MPa
20°C
FU
NFU
PITCH
CONTROL
UNIT
TEST

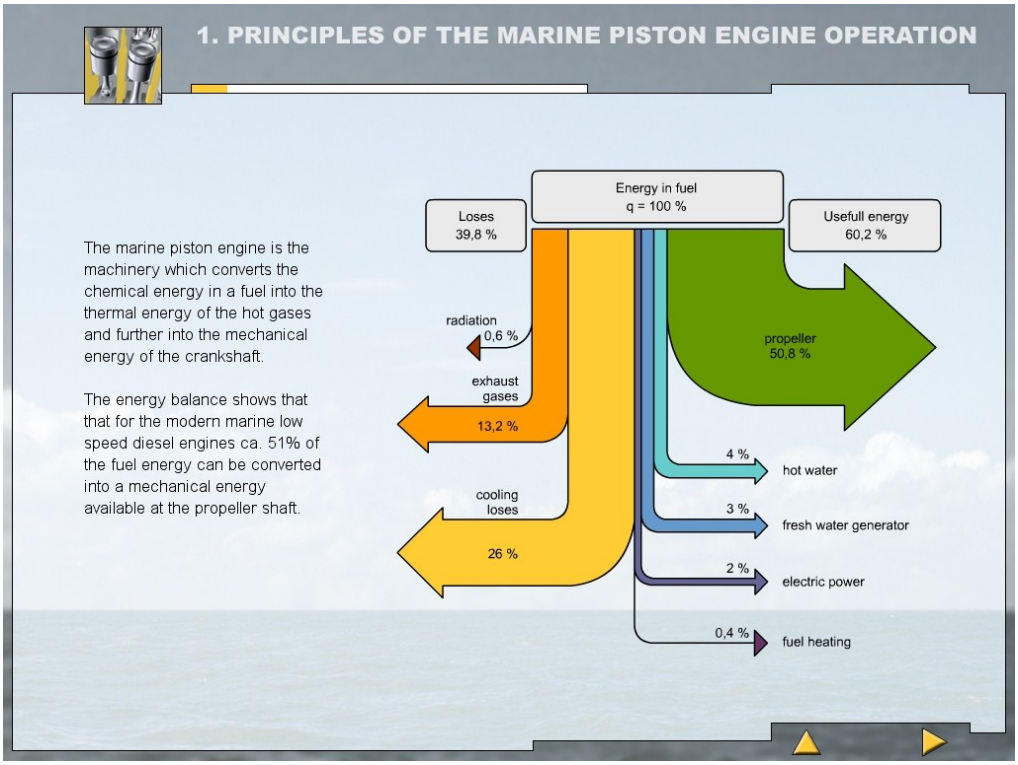
# DIESEL ENGINES

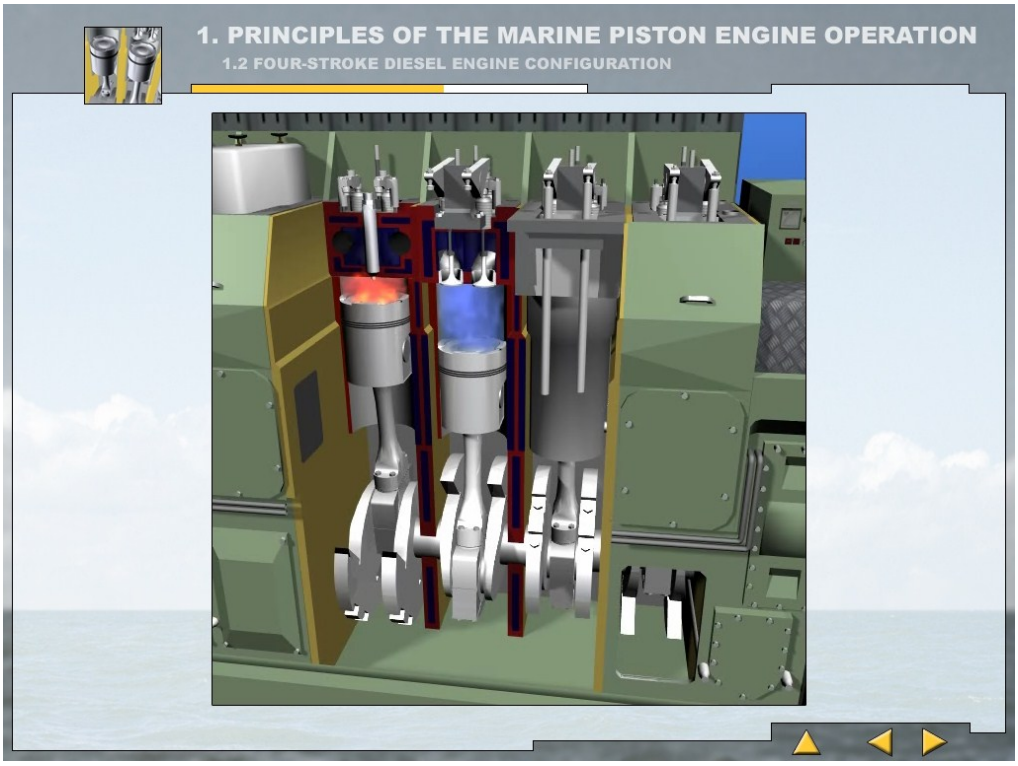


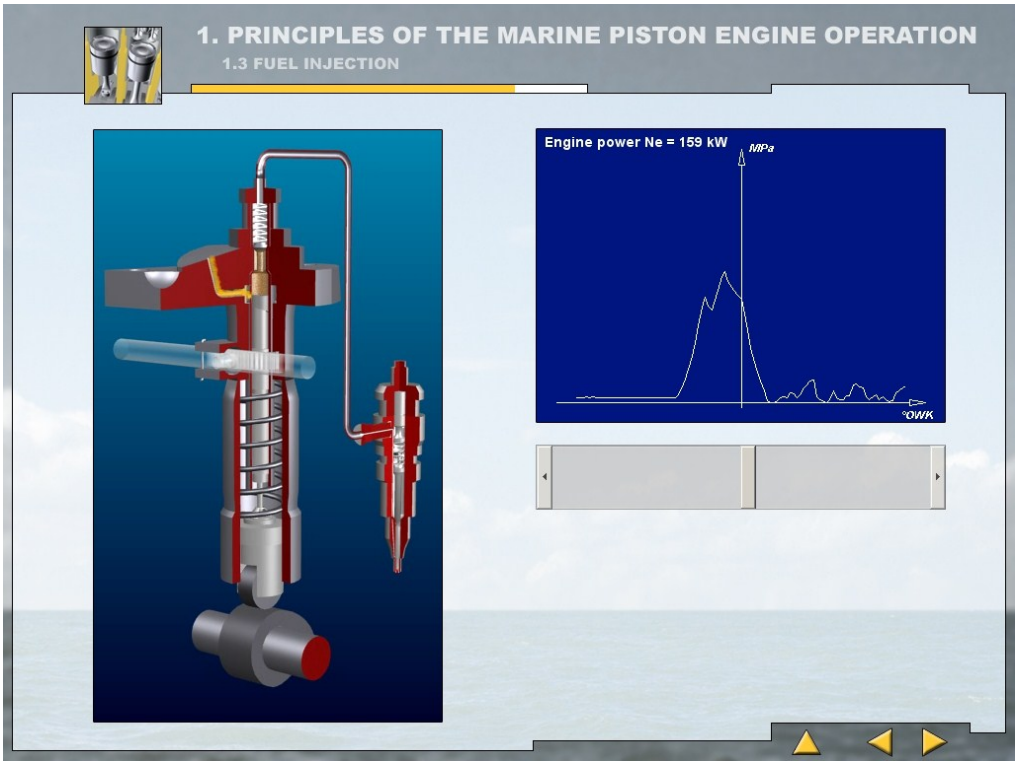

The educational program **DIESEL ENGINES** describes the principles of the diesel engines operation, their theory and their construction. The program describes how does the diesel engine work, what are its main parts and explains the theoretical background of its operation. The special attention has been paid to the phases of the fuel injection and combustion process. The turbocharging process has been discussed in a detail as well.

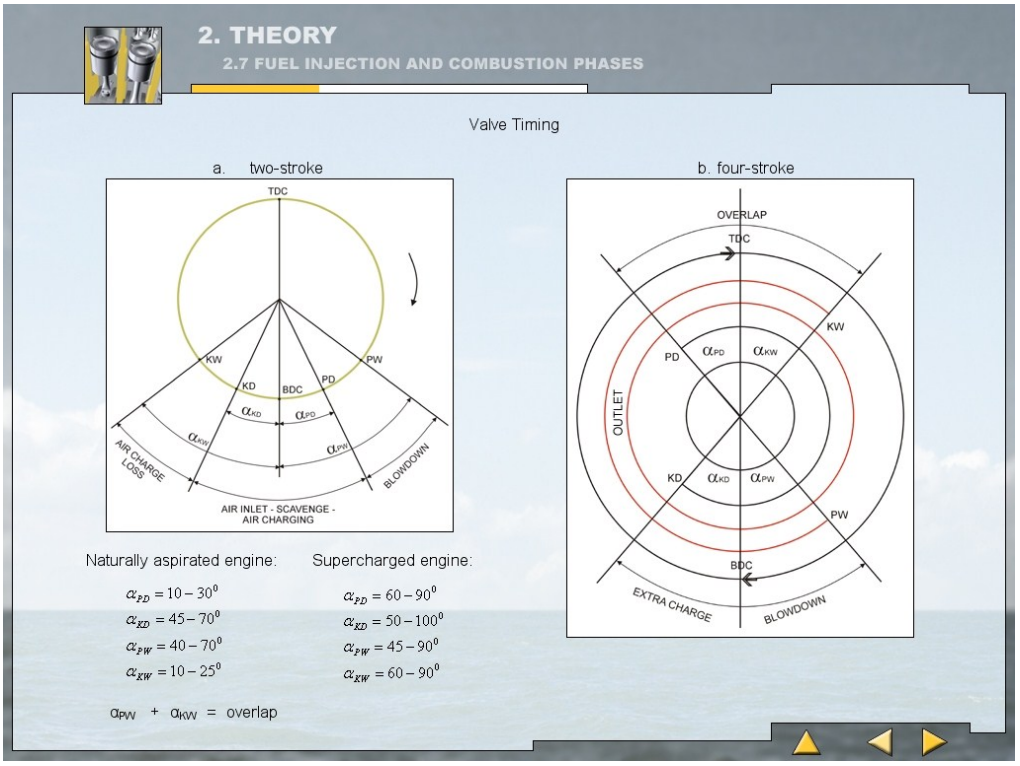
The **multimedia presentation** consists of main sections mentioned below:

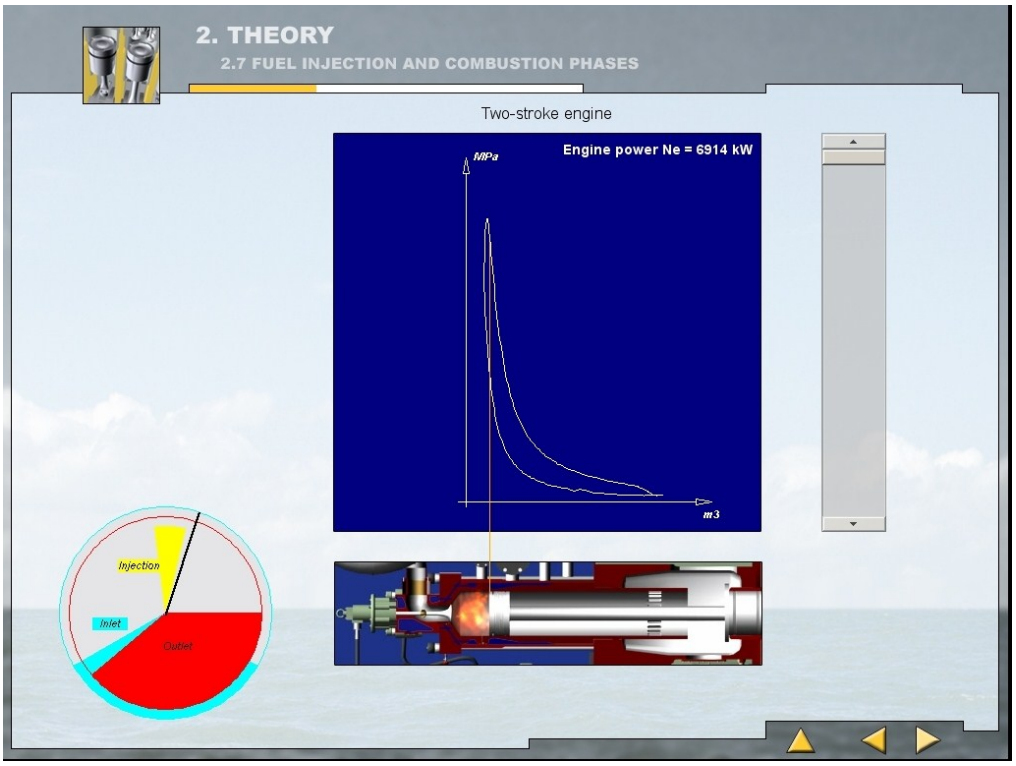
1. Principles of operation
    a. Two-stroke diesel engine configuration
    b. Four-stroke diesel engine configuration
    c. Fuel injection
2. Theory
    a. Assumptions for the theoretical heat cycles
    b. Types of theoretical heat cycles
    c. Theoretical cycles comparison
    d. Real engine cycles
    e. Real cycle of the two-stroke engine
    f. Real cycle of the four-stroke engine
    g. Fuel injection and combustion phases
    h. Engine operation measures
    i. Engine characteristics
    j. Supercharging
    k. Supercharging types
    l. Diesel engine and turbocharger interaction
3. Construction
    a. Two-stroke engine
    b. Four-stroke engine
4. Assessment




1. PRINCIPLES OF THE MARINE PISTON ENGINE OPERATION
1.2 FOUR-STROKE DIESEL ENGINE CONFIGURATION


1. PRINCIPLES OF THE MARINE PISTON ENGINE OPERATION
1.3 FUEL INJECTION
Engine power Ne = 159 kW
MPa
°OWK


2. THEORY
2.7 FUEL INJECTION AND COMBUSTION PHASES
Valve Timing
a. two-stroke
TDC
KW
KD
BDC
PD
PW
AIR CHARGE LOSS
BLOWDOWN
AIR INLET - SCAVENGE - AIR CHARGING
b. four-stroke
OVERLAP
TDC
KW
PD
OUTLET
KD
PW
BDC
EXTRA CHARGE
BLOWDOWN
Naturally aspirated engine:
$\alpha_{PD} = 10 - 30^0$
$\alpha_{KD} = 45 - 70^0$
$\alpha_{PW} = 40 - 70^0$
$\alpha_{KW} = 10 - 25^0$
Supercharged engine:
$\alpha_{PD} = 60 - 90^0$
$\alpha_{KD} = 50 - 100^0$
$\alpha_{PW} = 45 - 90^0$
$\alpha_{KW} = 60 - 90^0$
αPW + αKW = overlap


2. THEORY
2.7 FUEL INJECTION AND COMBUSTION PHASES
Two-stroke engine
MPa
Engine power Ne = 6914 kW
m3
Injection
Inlet
Outlet

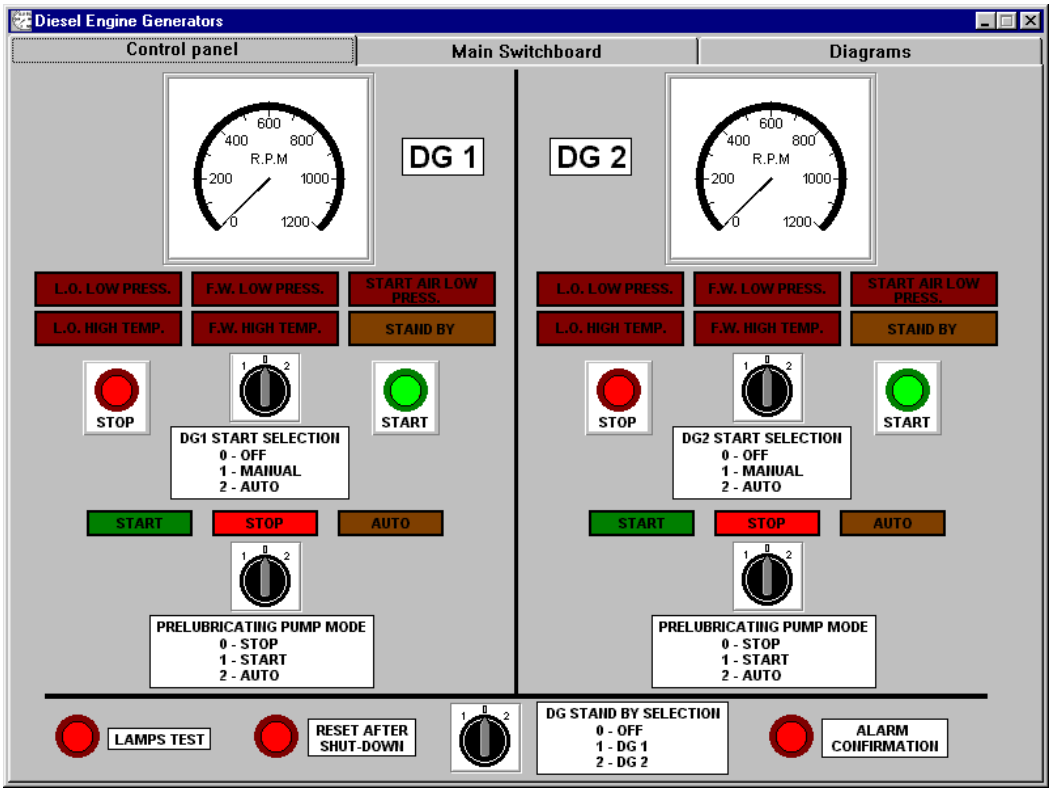
# DIESEL ENGINE GENERATORS

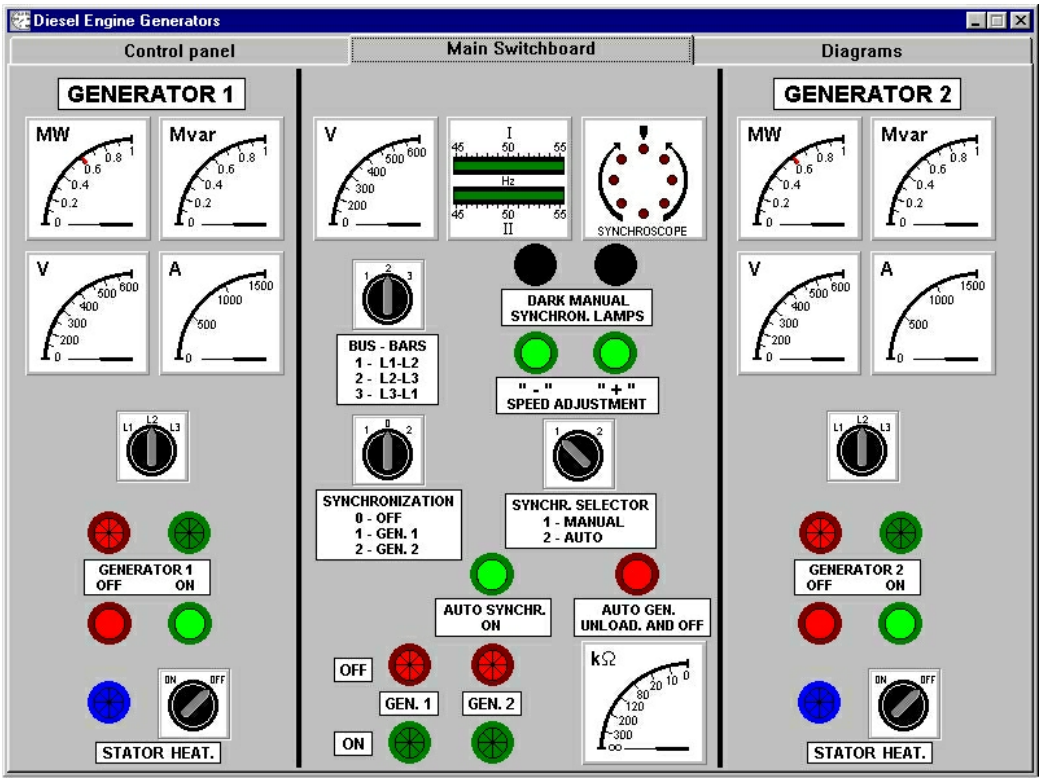
The **DIESEL ENGINE GENERATORS** - training simulator program's aim is to teach basic principles of how to operate marine diesel engine generators.

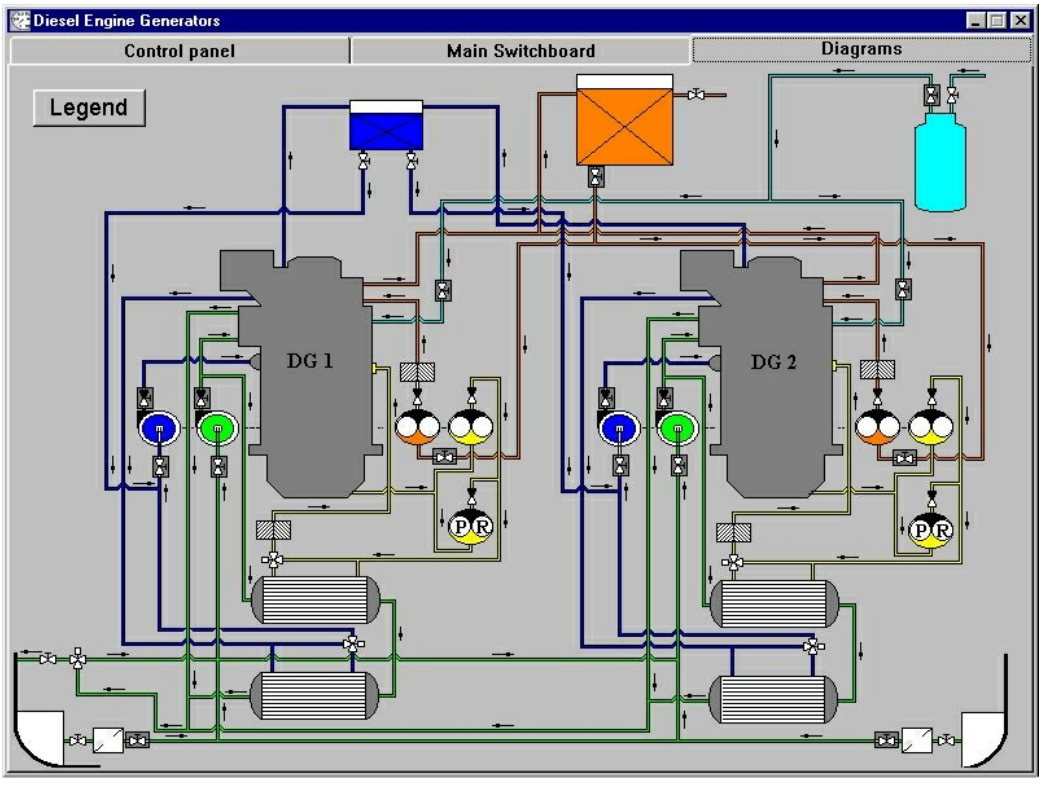
This program is based on two diesel engine generators, which work in a semi-automatic system.

The program consists of three parts:

1) Control panel
2) Main switchboard
3) Diagrams




Diesel Engine Generators
Control panel
Main Switchboard
Diagrams
GENERATOR 1
GENERATOR 2
MW
Mvar
V
A
SYNCHROSCOPE
BUS - BARS
1 - L1-L2
2 - L2-L3
3 - L3-L1
DARK MANUAL
SYNCHRON. LAMPS
" - "
" + "
SPEED ADJUSTMENT
SYNCHRONIZATION
0 - OFF
1 - GEN. 1
2 - GEN. 2
SYNCHR. SELECTOR
1 - MANUAL
2 - AUTO
AUTO SYNCHR.
ON
AUTO GEN.
UNLOAD. AND OFF
GENERATOR 1
OFF ON
GENERATOR 2
OFF ON
STATOR HEAT.
OFF
GEN. 1
GEN. 2
ON


Diesel Engine Generators
Control panel
Main Switchboard
Diagrams
Legend
DG 1
DG 2
P
R

# ECOSTREAM

## 1. Introduction

The ECOSTREAM SIMULATOR is intended for teaching the basic principles of how to operate a typical marine ecostream installation.

The EcoStream bilge water treatment system comprises four main functions:

- Forwarding/pumping
- Pre-treatment
- Separation
- Process control & monitoring

The simulator consists of the following elements:

1. Control Panel.
2. Diagram.

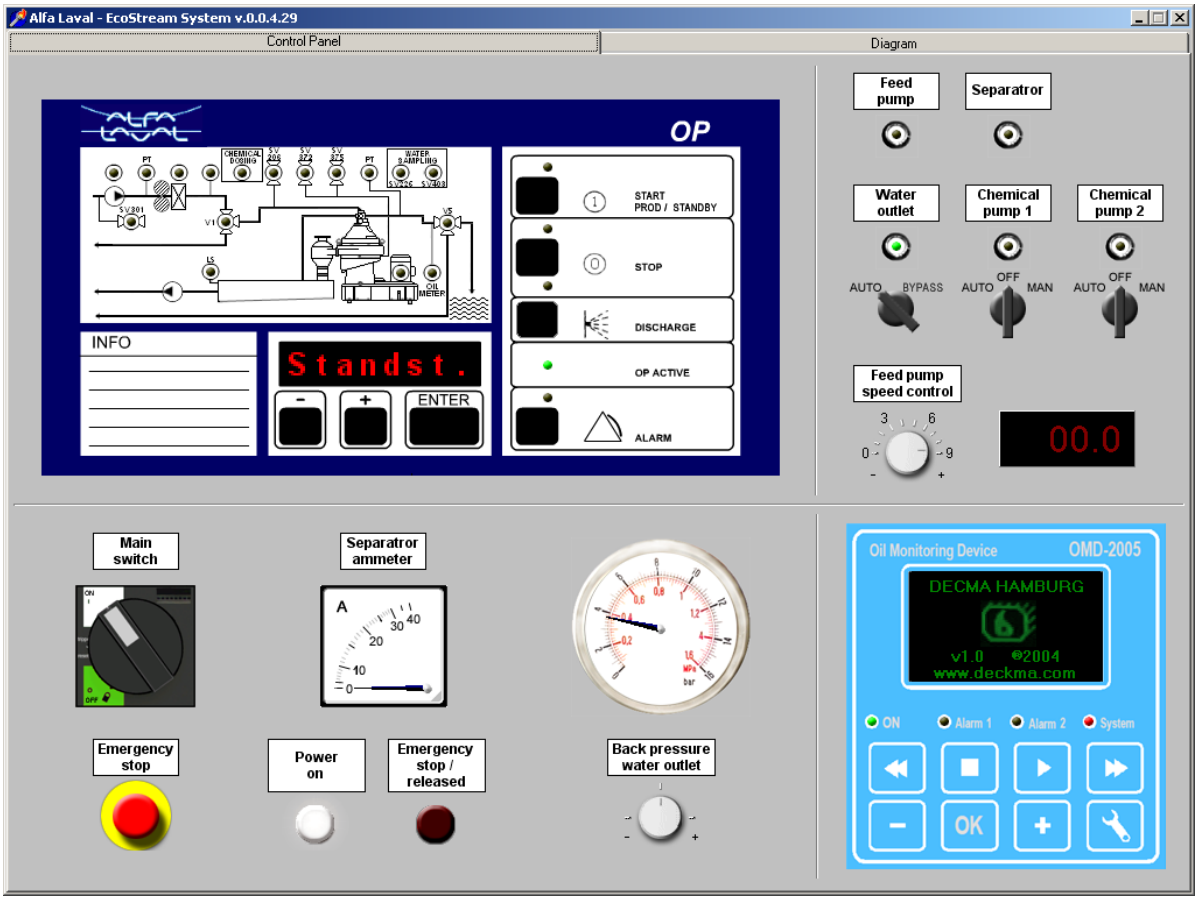



Fig.1 Control Panel

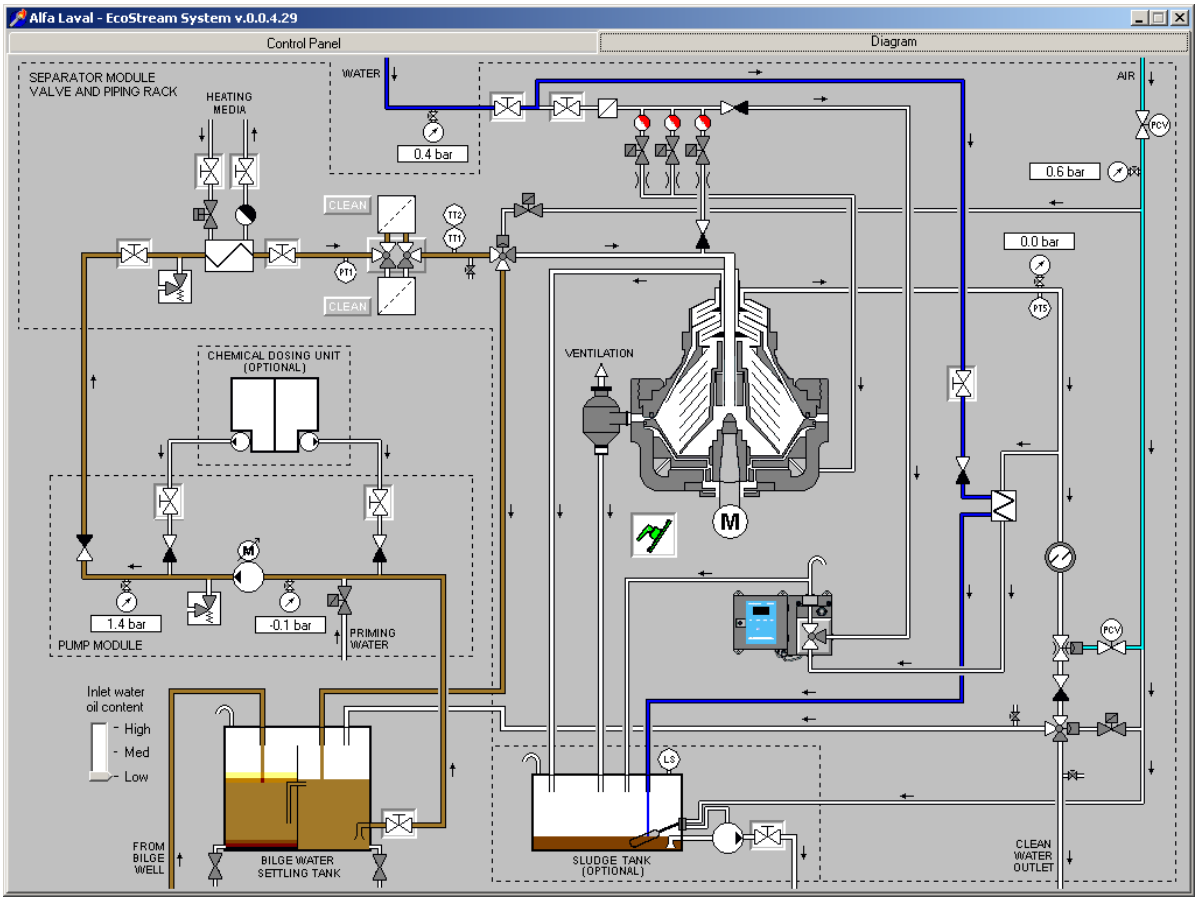



Fig. 2. Diagram

# ELECTRIC POWER PLANT

The educational program **ELECTRIC POWER PLANT** is intended for teaching the basic principles of how to operate a typical marine diesel engine generator.

The simulator is based on the diesel engine type L28/32H produced by MAN B&W and the generator type GDB-1410S/02 produced by Dozamel corporation. The power plant is controlled by Power Management System produced by DEIF corporation.

The program consists of two main parts:

- Multimedia presentation
- Simulator

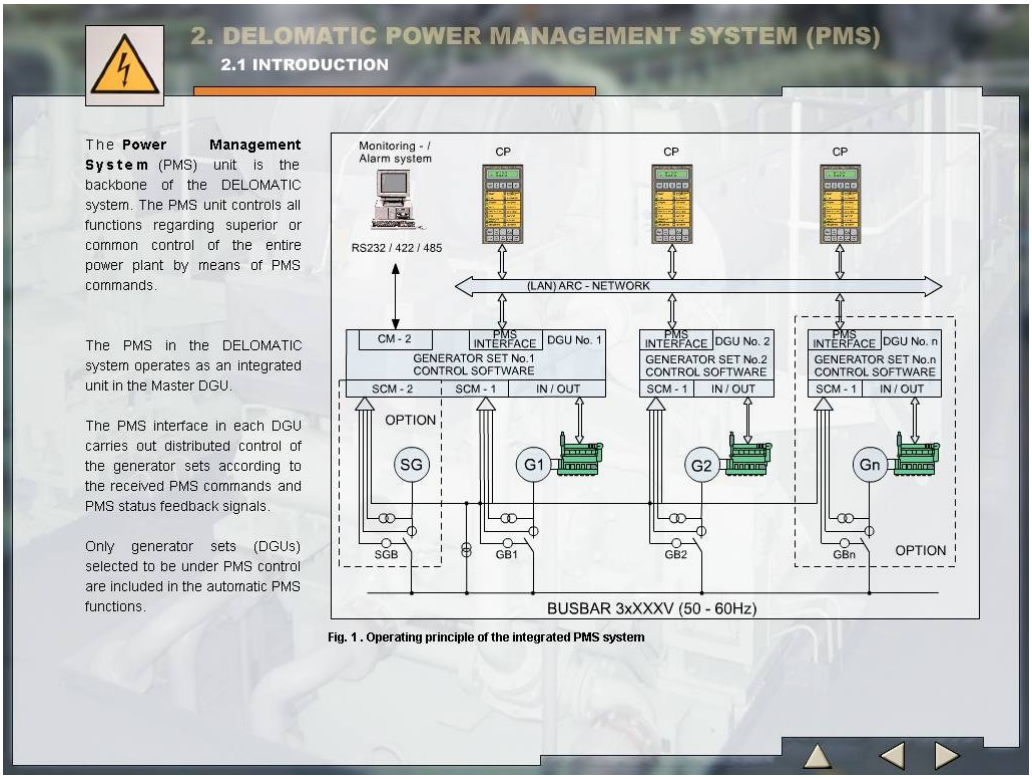


Fig. 1 . Operating principle of the integrated PMS system

The **multimedia presentation** part of the program consists of main sections mentioned below:

1. Introduction – general Power Plant description.

2. Description of the Power Management System.

3. Alarm system – alarm types and handling.

4. Menu system – menu structure and data readings.

5. Generator set control, supervision and protection.

6. System elements' photos.

7. Assessment - some questions about the theory and the practice in the skill test.

8. Simulator description.

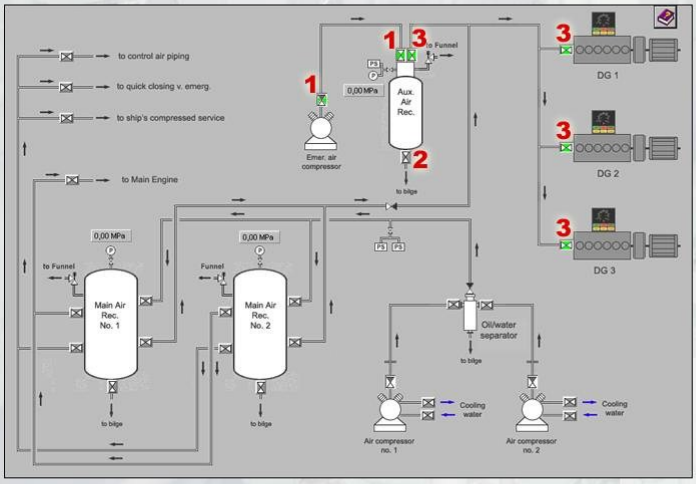
9. Operating instruction – simulator user's manual.

## 6. PHOTOS

Fig. 16 . Main air compressor

## 9. OPERATING INSTRUCTIONS

### 9.1 STARTING THE FIRST GENERATOR FROM DEAD ENGINE ROOM CONDITION




**Preparing starting air system**

1. Open valves from emergency air compressor to auxiliary air receiver.
2. Drain auxiliary air receiver.
3. Open valves to diesel engines.

The **simulator program** consists of the following parts:

1. Main switchboard
   - Generator 1 control panel
   - Generator 2 control panel
   - Generator 3 control panel
   - Prelubricating pumps control panel
   - Synchronisation panel

2. Power management system

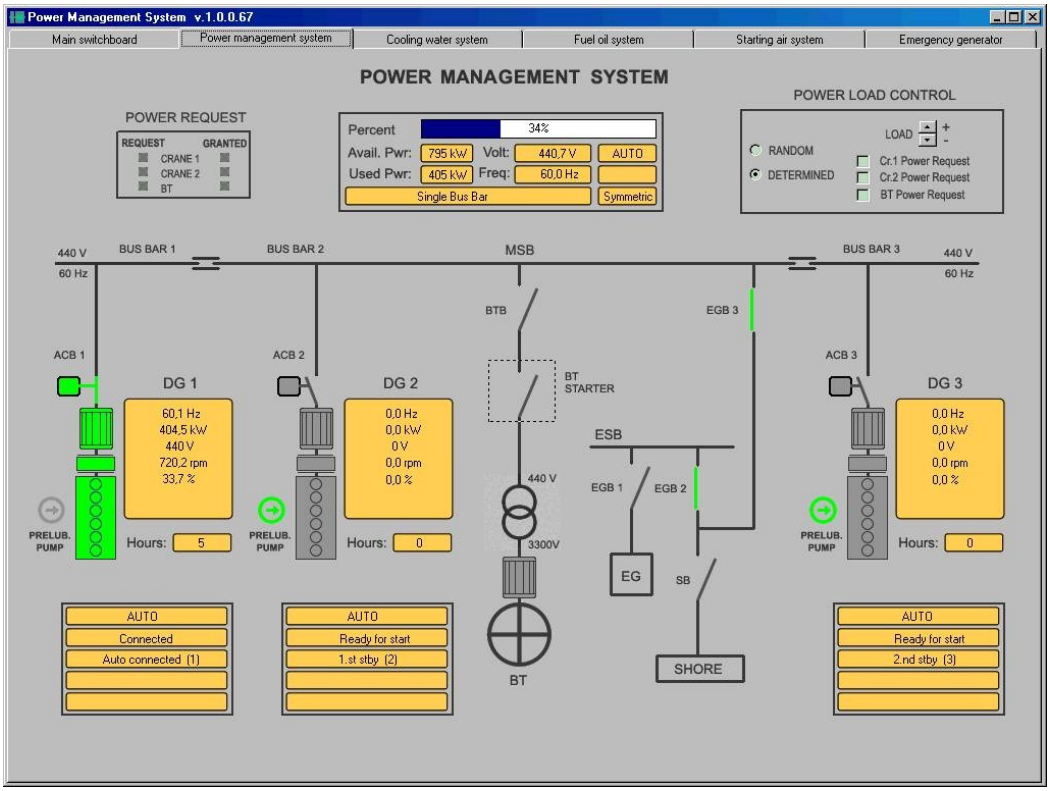
3. Central cooling water system
   - Control panel
   - Diagram

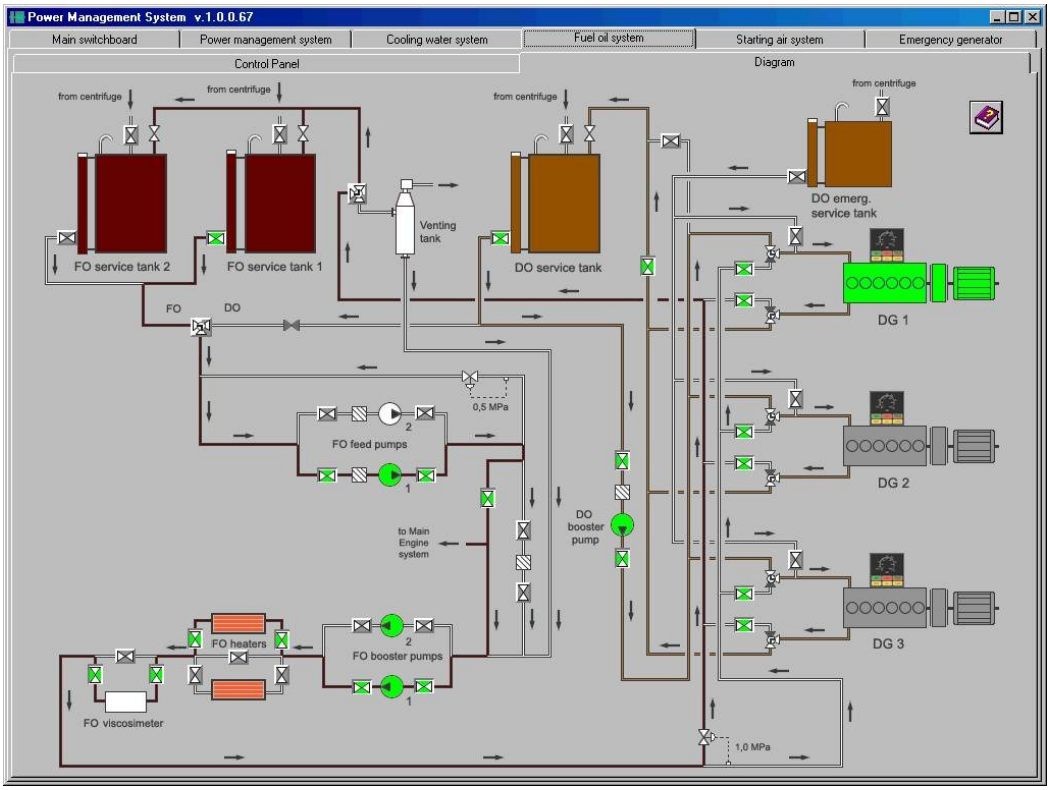
4. Fuel oil system
   - Control panel
   - Diagram

5. Starting air system
   - Control panel
   - Diagram

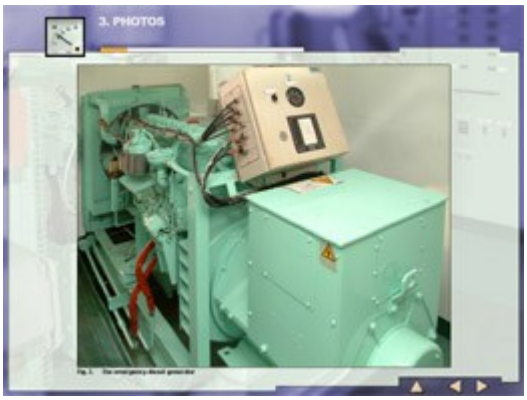
6. Emergency generator

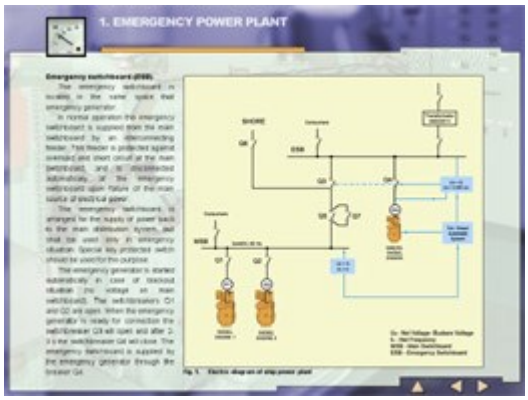
7. Diesel engine local control panel


Power Management System v.1.0.0.67
Main switchboard
Power management system
Cooling water system
Fuel oil system
Starting air system
Emergency generator
POWER MANAGEMENT SYSTEM
POWER REQUEST
REQUEST
GRANTED
CRANE 1
CRANE 2
BT
Percent
34%
Avail. Pwr:
795 kW
Volt:
440,7 V
AUTO
Used Pwr:
405 kW
Freq:
60,0 Hz
Single Bus Bar
Symmetric
POWER LOAD CONTROL
LOAD
RANDOM
DETERMINED
Cr.1 Power Request
Cr.2 Power Request
BT Power Request
440 V
60 Hz
BUS BAR 1
BUS BAR 2
MSB
BUS BAR 3
440 V
60 Hz
BTB
EGB 3
ACB 1
ACB 2
ACB 3
DG 1
60,1 Hz
404,5 kW
440 V
720,2 rpm
33,7 %
DG 2
0,0 Hz
0,0 kW
0 V
0,0 rpm
0,0 %
DG 3
0,0 Hz
0,0 kW
0 V
0,0 rpm
0,0 %
BT
STARTER
ESB
440 V
3300V
EGB 1
EGB 2
EG
SB
SHORE
PRELUB. PUMP
Hours:
5
0
0
AUTO
Connected
Auto connected (1)
AUTO
Ready for start
1.st stby (2)
AUTO
Ready for start
2.nd stby (3)


Power Management System v.1.0.0.67
Main switchboard
Power management system
Cooling water system
Fuel oil system
Starting air system
Emergency generator
Control Panel
Diagram
from centrifuge
FO service tank 2
FO service tank 1
Venting tank
DO service tank
DO emerg. service tank
FO
DO
DG 1
0,5 MPa
FO feed pumps
DG 2
DO booster pump
to Main Engine system
FO heaters
FO booster pumps
DG 3
FO viscosimeter
1,0 MPa

# EMERGENCY POWER PLANT




The educational program **EMERGENCY POWER PLANT** is intended for teaching the basic principles of how to operate a typical emergency marine diesel engine generator.

The program is based on the emergency diesel engine type D2866 E produced by MAN and the generator type STAMFORD UCM 274 G.

The program consists of two main parts:

- Multimedia presentation
- Simulator

The **multimedia presentation** part of the program consists of main sections mentioned below:

1. General emergency power plant description.
2. Main Components Description.
3. System elements' photos.
4. Operating Instructions.
5. Operating instruction - simulator user's manual.
6. Assessment - some questions about the theory and the practice in the skill test.

The **simulator program** consists of the following parts:

1. Fuel Oil Tank
2. Diesel Generator
3. Diesel Generator Control Panel
4. Emergency Transformers Boxes
5. Battery Charger
6. Emergency Switchboard

   The **emergency switchboard** consists of the following fields:

   a. Generator Panel

   b. Shore Supply Switch Panel

   c. Alarm Panel

   d. Shore Supply Control Panel

   e. Emergency Transformers Panel

   f. Emergency Consumers Panels

# FIXED DELIVERY PUMP STEERING GEAR INSTALLATION

The educational program **FIXED DELIVERY PUMP STEERING GEAR INSTALLATION** is intended for teaching the fundamental principles of how to operate this kind of steering gear.

The program consists of two main parts:

- Multimedia presentation
- Simulator

The **multimedia presentation** part of the program consists of main sections mentioned below:

1) System description
    a) mechanical equipment
    b) electrical equipment

2) Operating instructions
    a) operating mode
    b) starting procedure
    c) stopping procedure

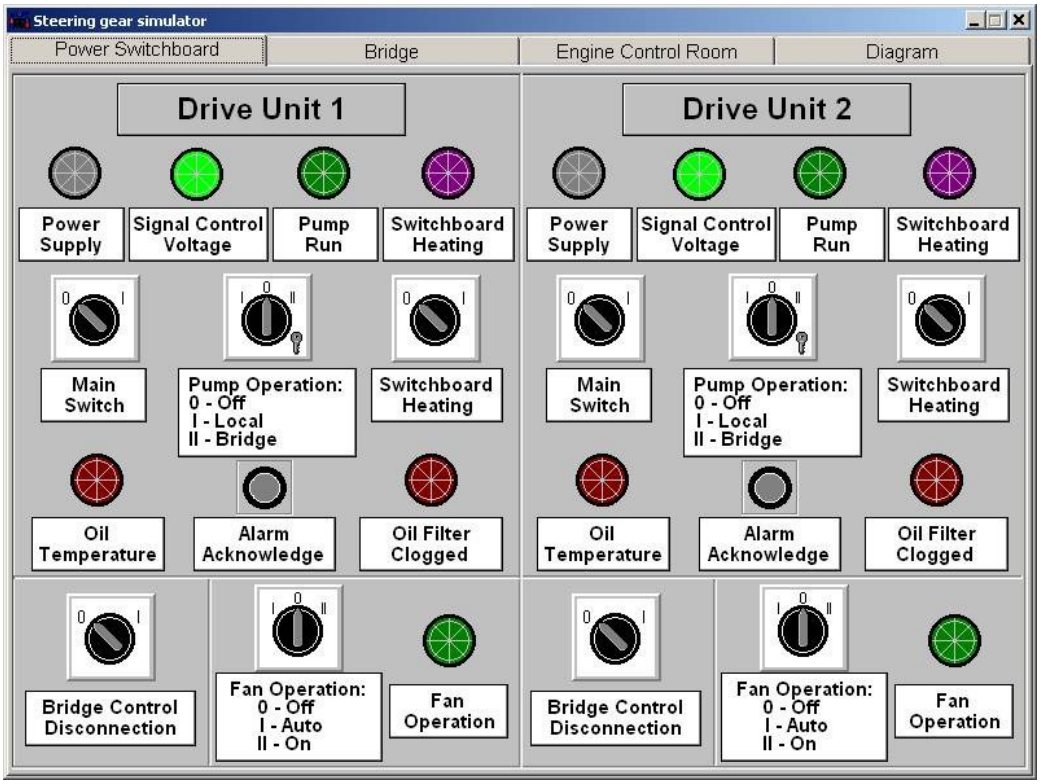
3) Test

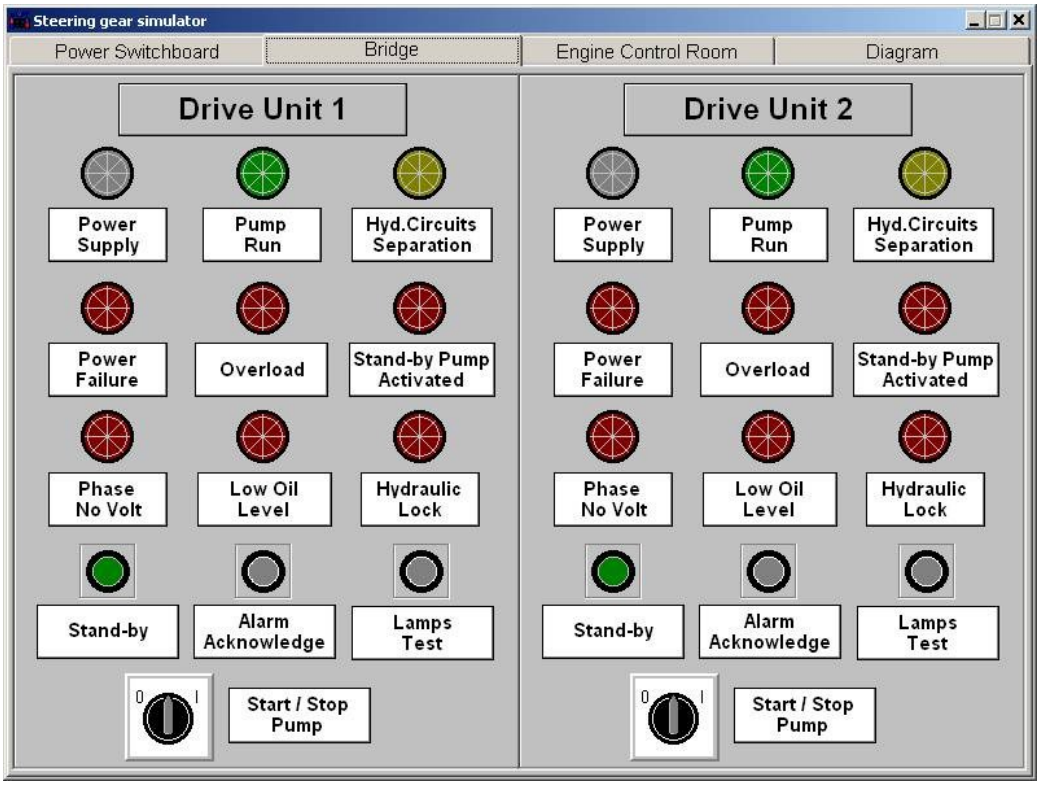
STEERING GEAR MS320
RUDDER STOCK HOLE
VENT VALVE
PISTON ROD
RUDDER TILLER
GREASE NIPPLE
MENU
RUDDER ACTUATOR UNIT

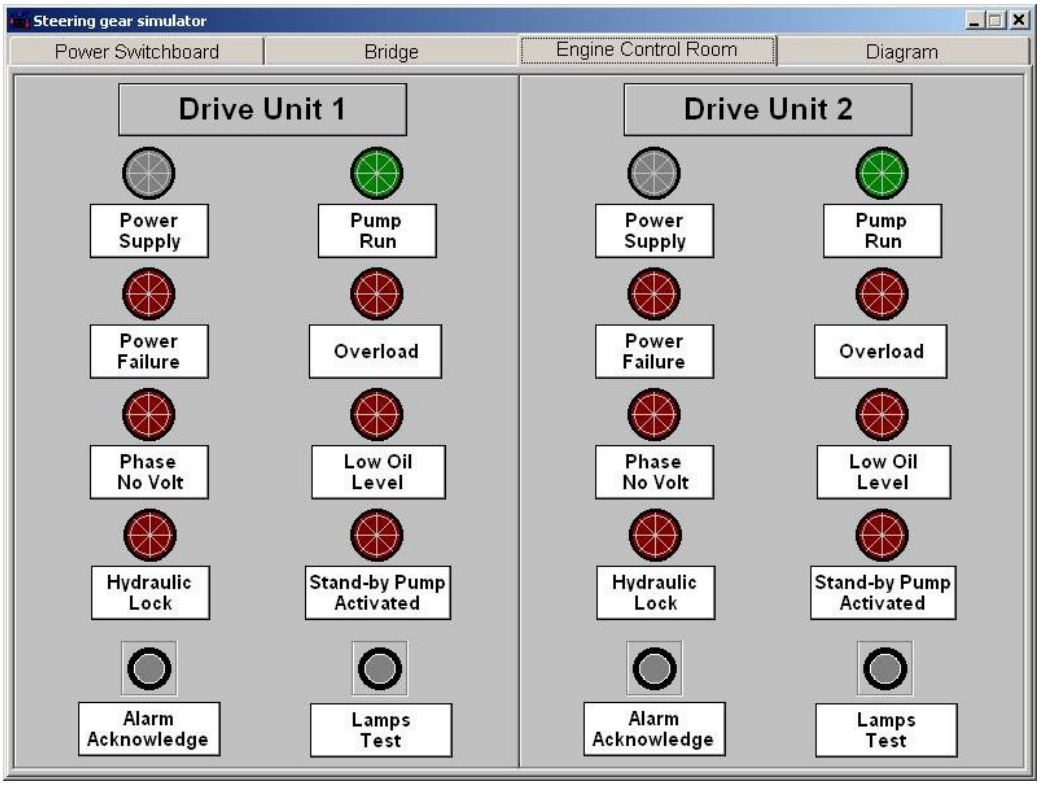
STEERING GEAR MS320
PILOT VALVE COIL
PILOT STAGE SPOOL
MANUAL OVER-RIDE TO SHIFT PILOT STAGE MECHANICALLY
ADJUSTMENT VALVE BLOCK
MAIN STAGE SPOOL
INDUCTIVE SEN-SING ELEMENT OF MARGINAL MAIN VALVE POSITION
MENU
PILOT OPERATED, SELENOID CONTROLLED DIRECTIONAL VALVE

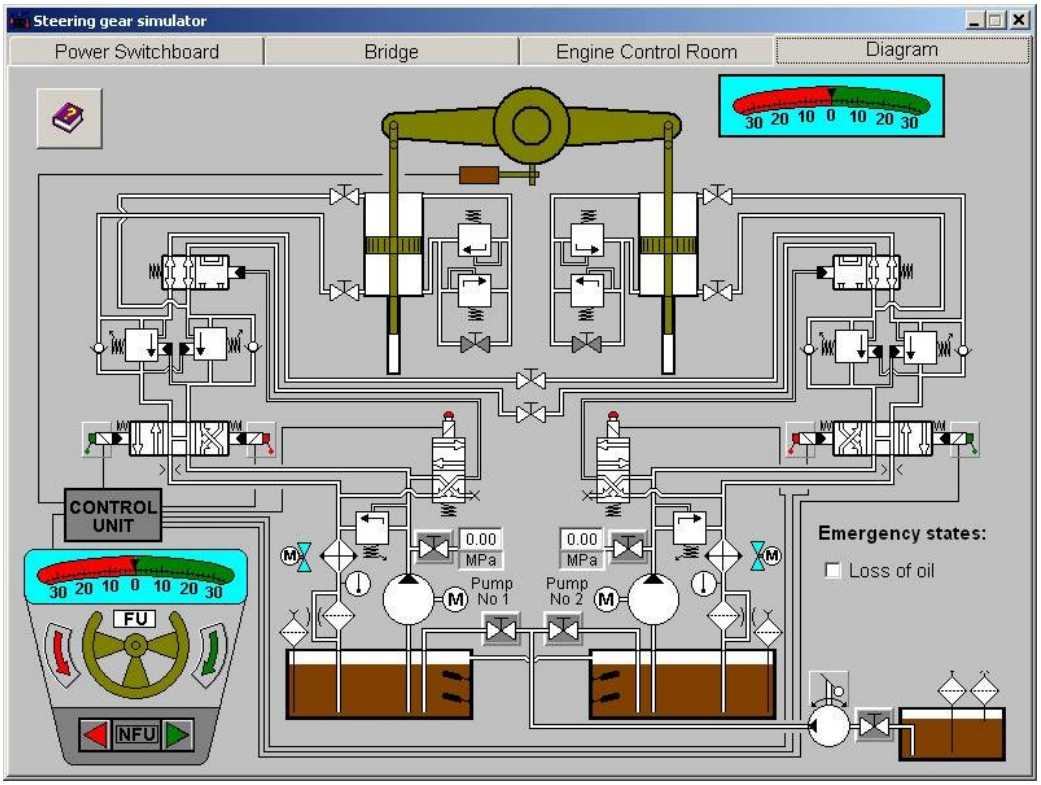
The **simulator program** consists of the following parts:

1) installation diagram
2) power switchboard panel
3) bridge control panel
4) engine control room panel




Steering gear simulator
Power Switchboard
Bridge
Engine Control Room
Diagram
Drive Unit 1
Power Supply
Pump Run
Hyd.Circuits Separation
Power Failure
Overload
Stand-by Pump Activated
Phase No Volt
Low Oil Level
Hydraulic Lock
Stand-by
Alarm Acknowledge
Lamps Test
0
I
Start / Stop Pump
Drive Unit 2
Power Supply
Pump Run
Hyd.Circuits Separation
Power Failure
Overload
Stand-by Pump Activated
Phase No Volt
Low Oil Level
Hydraulic Lock
Stand-by
Alarm Acknowledge
Lamps Test
0
I
Start / Stop Pump


Steering gear simulator
Power Switchboard
Bridge
Engine Control Room
Diagram
Drive Unit 1
Power Supply
Pump Run
Power Failure
Overload
Phase No Volt
Low Oil Level
Hydraulic Lock
Stand-by Pump Activated
Alarm Acknowledge
Lamps Test
Drive Unit 2
Power Supply
Pump Run
Power Failure
Overload
Phase No Volt
Low Oil Level
Hydraulic Lock
Stand-by Pump Activated
Alarm Acknowledge
Lamps Test

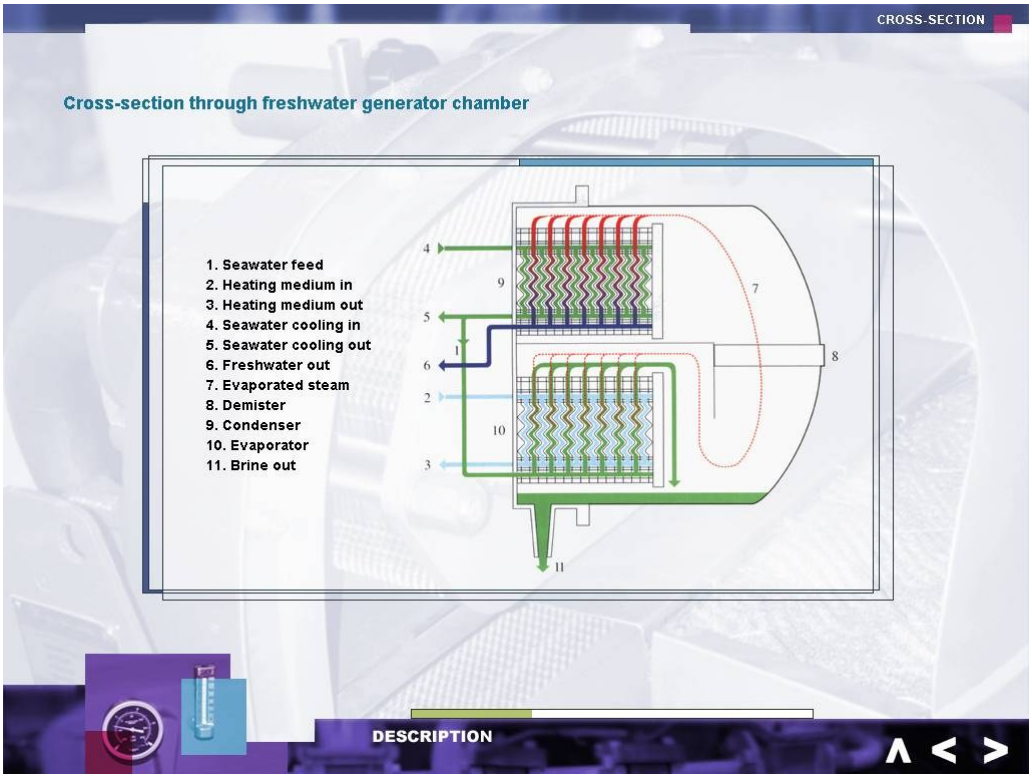

Steering gear simulator
Power Switchboard
Bridge
Engine Control Room
Diagram
30 20 10 0 10 20 30
CONTROL UNIT
30 20 10 0 10 20 30
FU
NFU
0.00
MPa
Pump No 1
0.00
MPa
Pump No 2
Emergency states:
Loss of oil

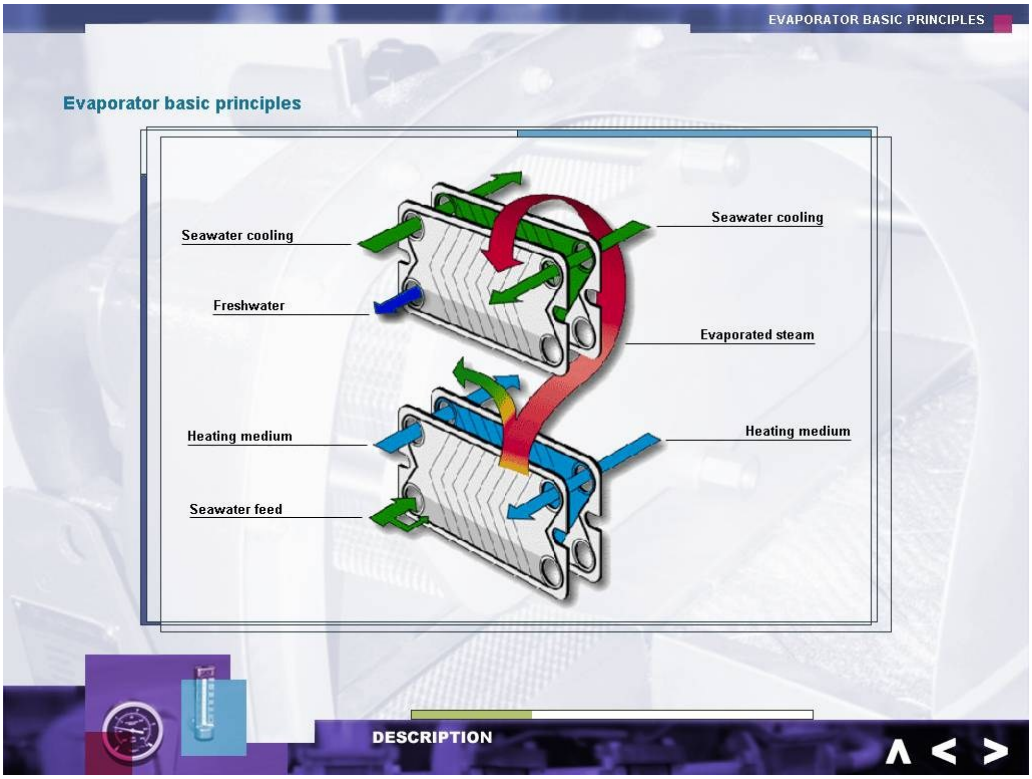
# FRESHWATER GENERATOR

The educational program **FRESHWATER GENERATOR** is intended for teaching the basic principles of how to operate a Alfa Laval JWP-26-C series Freshwater Generator.

The program consists of two main parts:

- Multimedia presentation
- Simulator





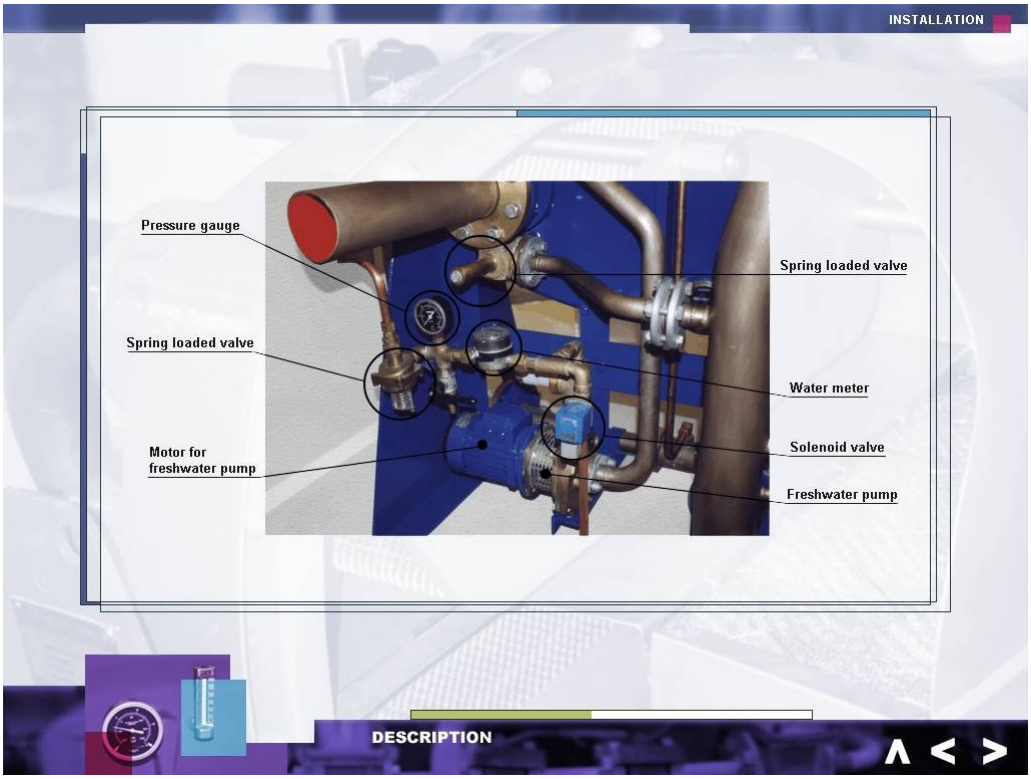

The multimedia presentation part of the program consists of main sections mentioned below:

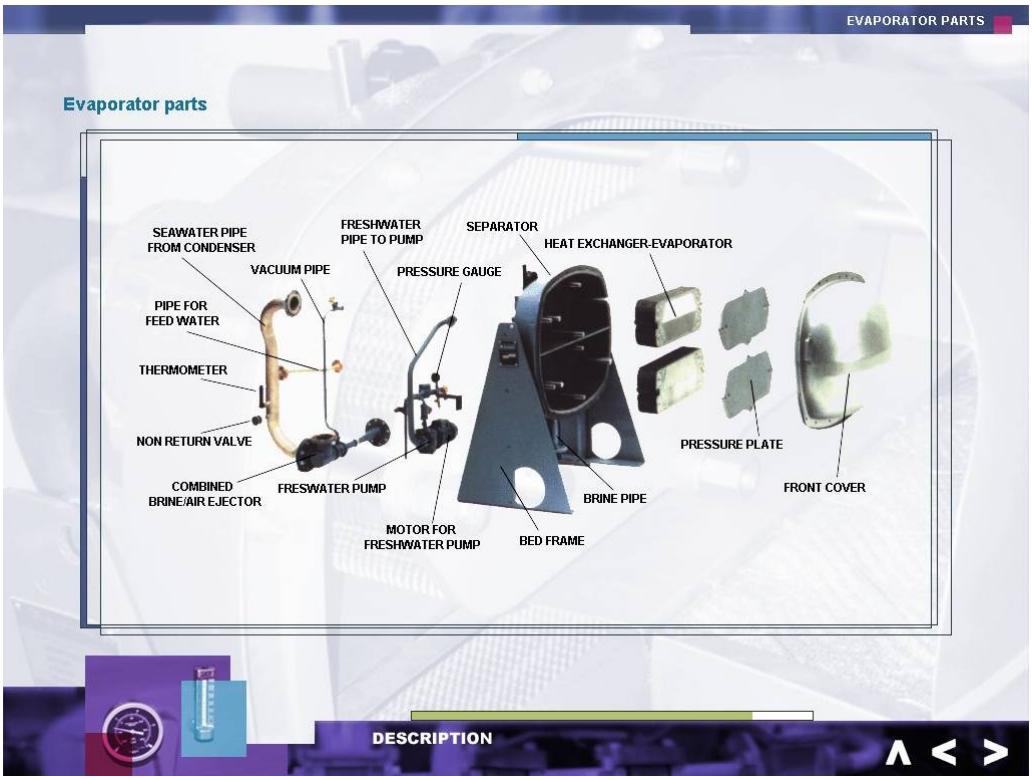
1. Description.

    a) General informations
    b) Working principle
    c) Installation layout
    d) Equipment
    e) Technical information

2. Operating procedures.

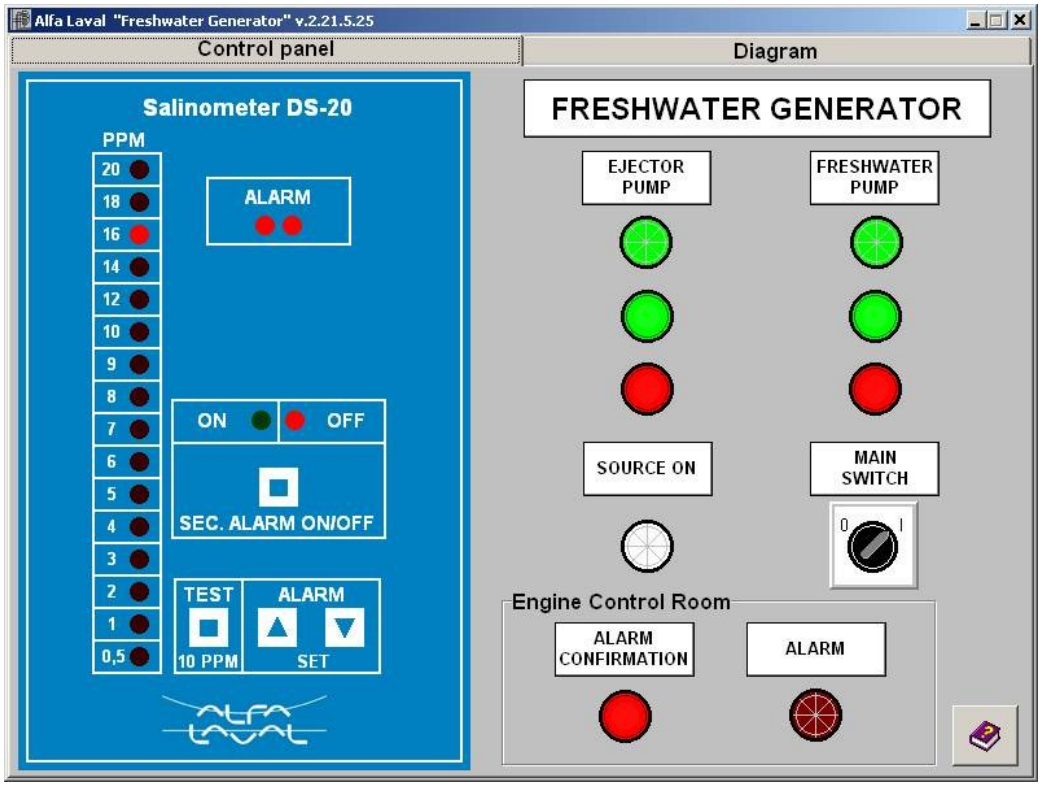
3. Assessment - some questions about the theory and the practice in the skill test.

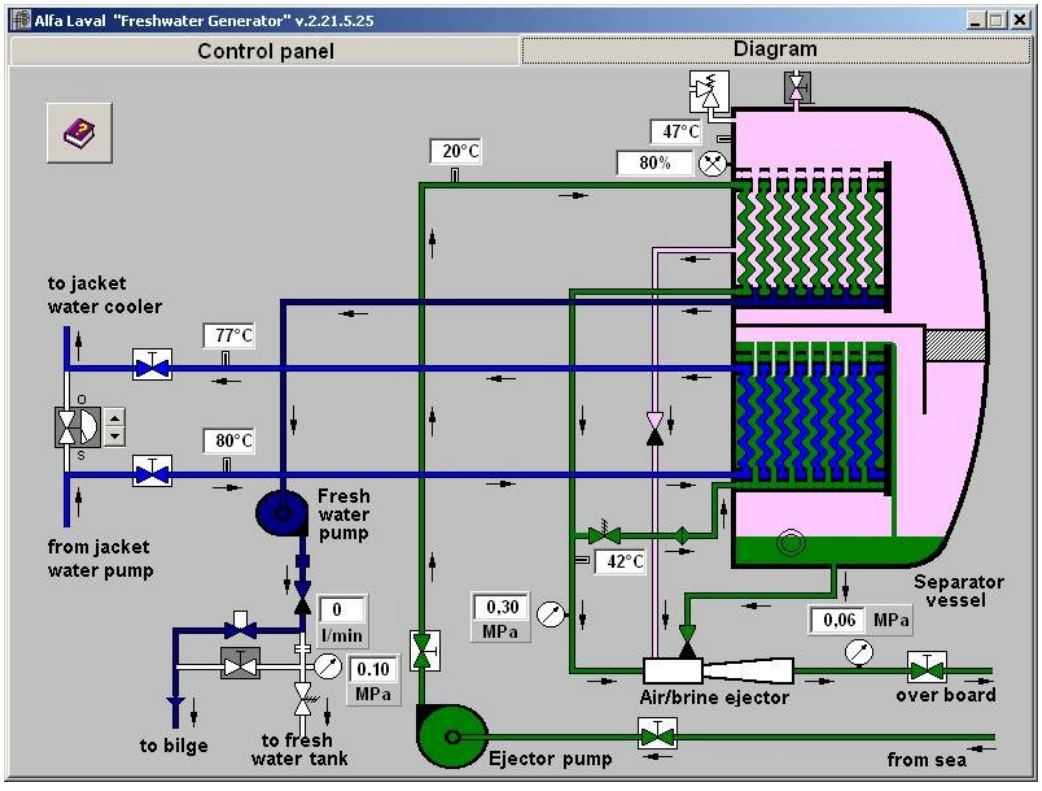

INSTALLATION
Pressure gauge
Spring loaded valve
Spring loaded valve
Water meter
Motor for freshwater pump
Solenoid valve
Freshwater pump
DESCRIPTION


EVAPORATOR PARTS
Evaporator parts
SEAWATER PIPE FROM CONDENSER
VACUUM PIPE
FRESHWATER PIPE TO PUMP
PRESSURE GAUGE
SEPARATOR
HEAT EXCHANGER-EVAPORATOR
PIPE FOR FEED WATER
THERMOMETER
NON RETURN VALVE
COMBINED BRINE/AIR EJECTOR
FRESWATER PUMP
MOTOR FOR FRESHWATER PUMP
BED FRAME
BRINE PIPE
PRESSURE PLATE
FRONT COVER
DESCRIPTION

The **simulator program** is interactive i.e. it enable the realistic presentation of the Alfa Laval JWP-26-C series Freshwater Generator functioning. System reaction are identically as it happens during normal operations The simulator consists of the following parts:

- Control Panel
- System Diagram



# FRESHWATER GENERATOR 3D

## 1. Introduction

The educational program FRESHWATER GENERATOR SIMULATOR is intended for teaching the basic principles of how to operate a typical marine freshwater generator.
The program is based on the freshwater generator (vacuum evaporator) type JW26-C produced by ALFA LAVAL.

The freshwater generator consists of the following main components:

1. Freshwater generator vessel with:
   - evaporator section /plate heat exchanger/,
   - demister,
   - condenser section /plate heat exchanger/,
   - fittings / air valve, safety valve, vacuum gauge, thermometer and sigh glass/.
2. Combined air/brine ejector.
3. Ejector pump.
4. Freshwater pump.
5. Control panel with salinometer and Engine Control Room's alarm block.
6. Mineralizer.

Fig. 1. Freshwater generator – general view

The simulator diagram shows the basic configuration of freshwater generator and status of main element and valves. Basic parameters of the system are also presented.

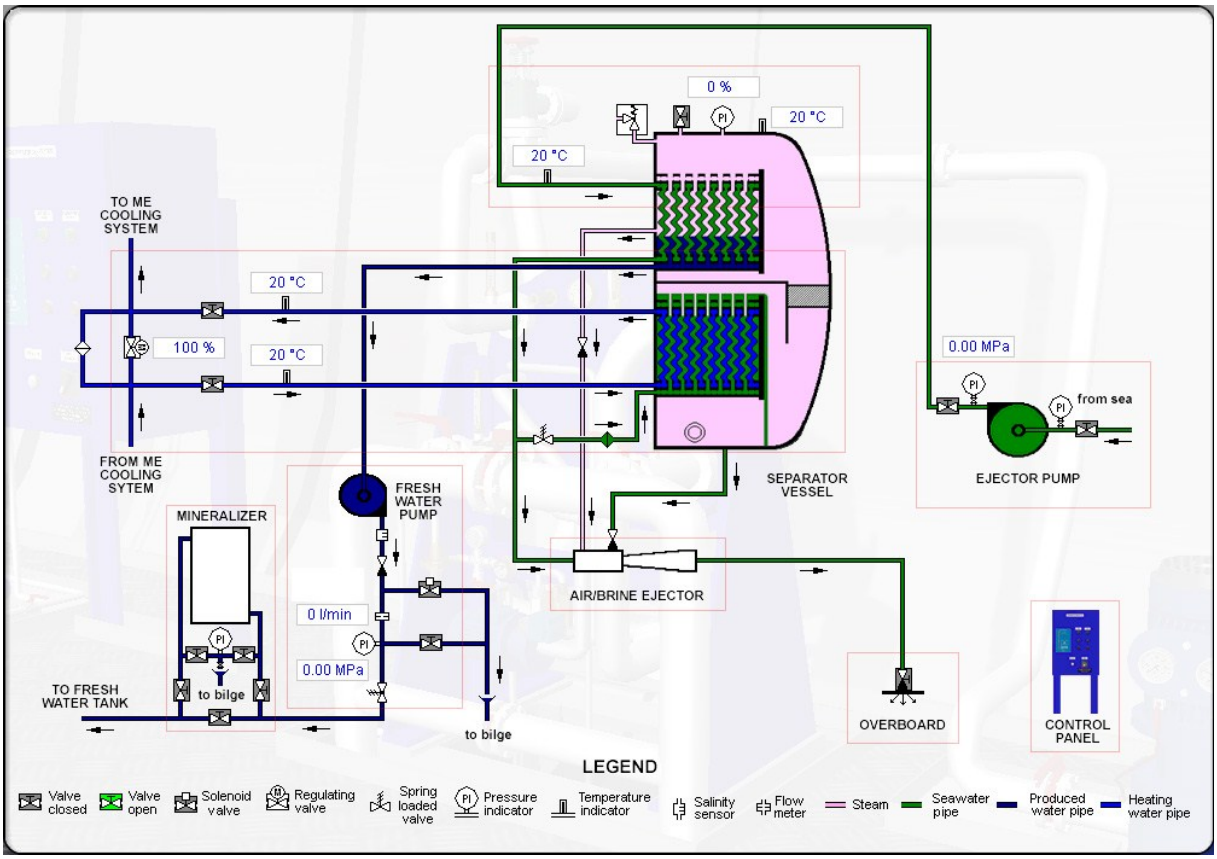



Fig. 2. Freshwater generator plant diagram

This simulator allows two ways of navigation in 3D environment:

1. Selection of system's views (Main View, Ejector Pump, Control Panel, Mineralizer). This items are available from menu (fig.3).
2. Zooming of selected parts of system's elements (by mouse clicking on yellow boxes).

Fig. 3. Zooming possibilities

# FUEL CONDITIONING MODULE

The educational program **FUEL CONDITIONING MODULE** is intended for teaching the basic principles of how to operate Alfa Laval's Fuel Conditioning Module.

The Alfa Laval's Fuel Conditioning Module (FCM) is an automated two-stage pressurized fuel booster system used for diesel engines in the shipping and power station industries. It supplies clean filtered fuel to the engine at the flow rate, pressure and viscosity specified by the engine manufacturer.

The program consists of two main parts:

- Multimedia presentation
- 3D Simulator

The **multimedia presentation** part of the program consists of main sections mentioned below:

1. Description of the **Fuel Conditioning Module System** (introduction on the working principles and basic modules).

    a) Purpose of the system
    b) Application
    c) Typical system
    d) Typical Layout

2. Operating instruction – FCM user's manual.

3. Parameter list - introduction of the parameters and parameter lists accessing.

4. Alarms - introduction of the alarms and fault finding.

5. Assessment - some questions about the theory and the practice in the skill test.

## 1. SYSTEM DESCRIPTION

### 1.4 TYPICAL LAYOUT

**Three-way DO/HFO changeover valve**

This valve controls changeover from diesel oil to heavy fuel oil after startup and, if required from heavy fuel oil to diesel oil at low loads.

Use of an electric valve enables the operator to set the changeover time in the process controller to obtain a smooth changeover between DO and HFO and between HFO and DO.

Three way DO / HFO change-over valve

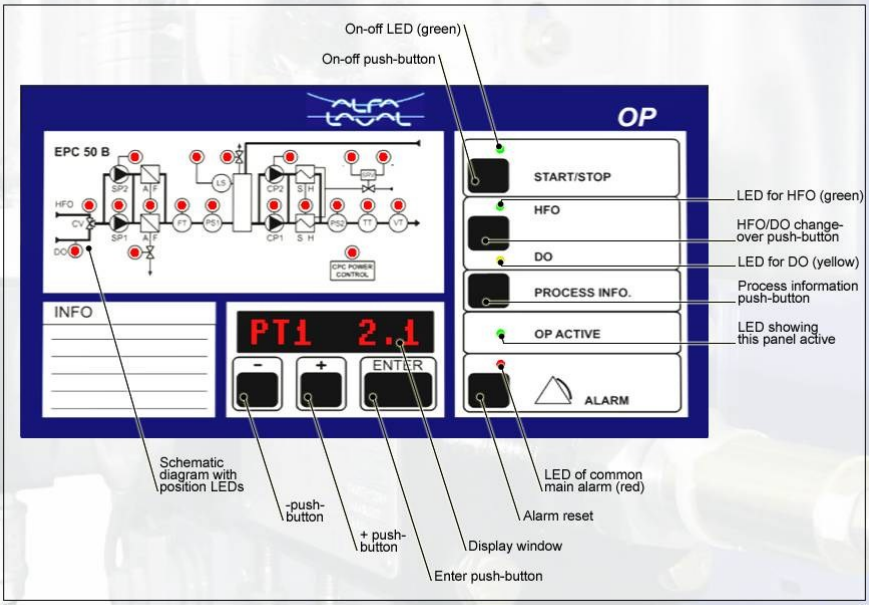
**Low pressure supply pumps**

Oil from the day tank enters the system via the three way valve and into the suction of the low pressure supply pumps. Operation of this section under pressure eliminates the problems of gasification and cavitation that are associated with high fuel temperatures (120 – 150° C). This will ensure an even fuel flow and prevent damage to the pumps.

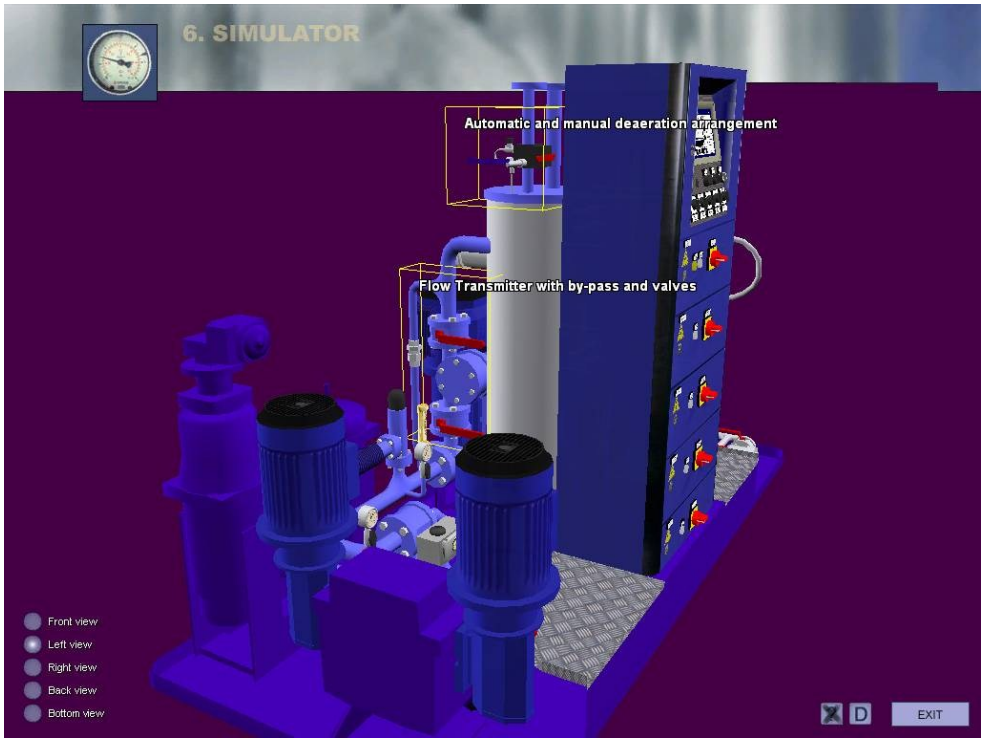
Supply pumps

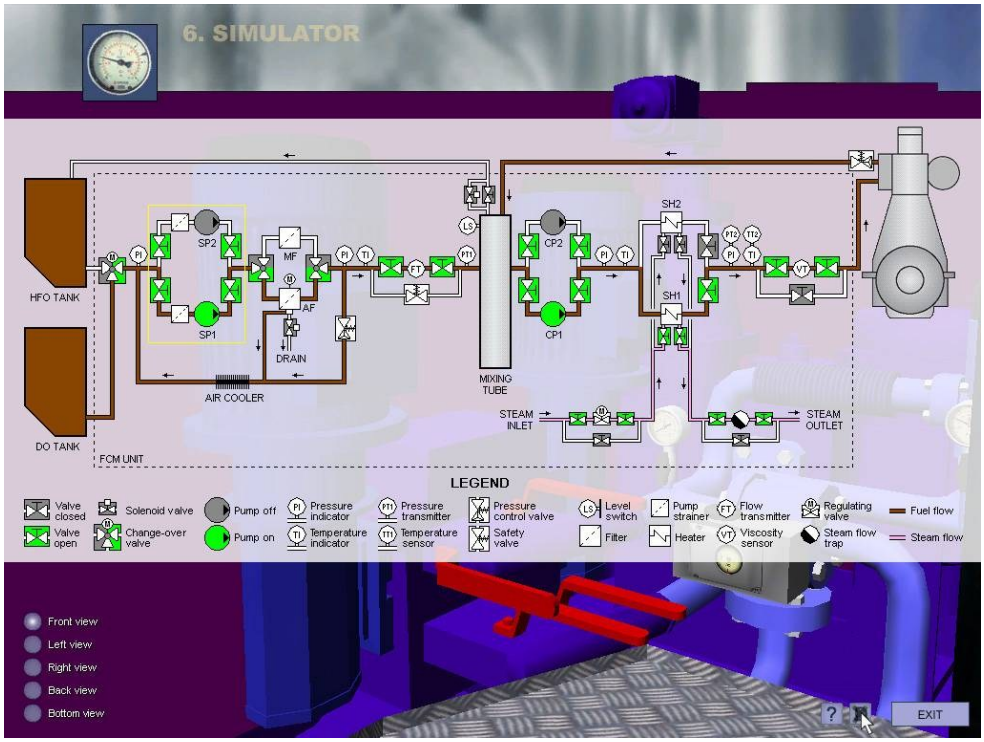
## 3. PARAMETER LIST

### 3.1 PARAMETER SETTING



The **simulator program** introduces 3D model of the Fuel Conditioning Module, based on the real equipment. In order to create the impression of working in the real environment, it provides 3D sound which can be listened on 2, 4 or more speakers.



# FUEL OIL TREATMENT PLANT

The educational program **FUEL OIL TREATMENT PLANT** is designated for learning the essential principles of the marine fuel oil treatment plant maintenance.

The program is based on high speed centrifugal separators with self-cleaning bowls type OSA - produced by GEA Westfalia Separator AG and designed for unsupervised operation conform to the regulation of the classification societies.

The program consists of two main parts:

- Multimedia presentation
- Simulator

The **multimedia presentation** part of the program consists of main sections mentioned below:

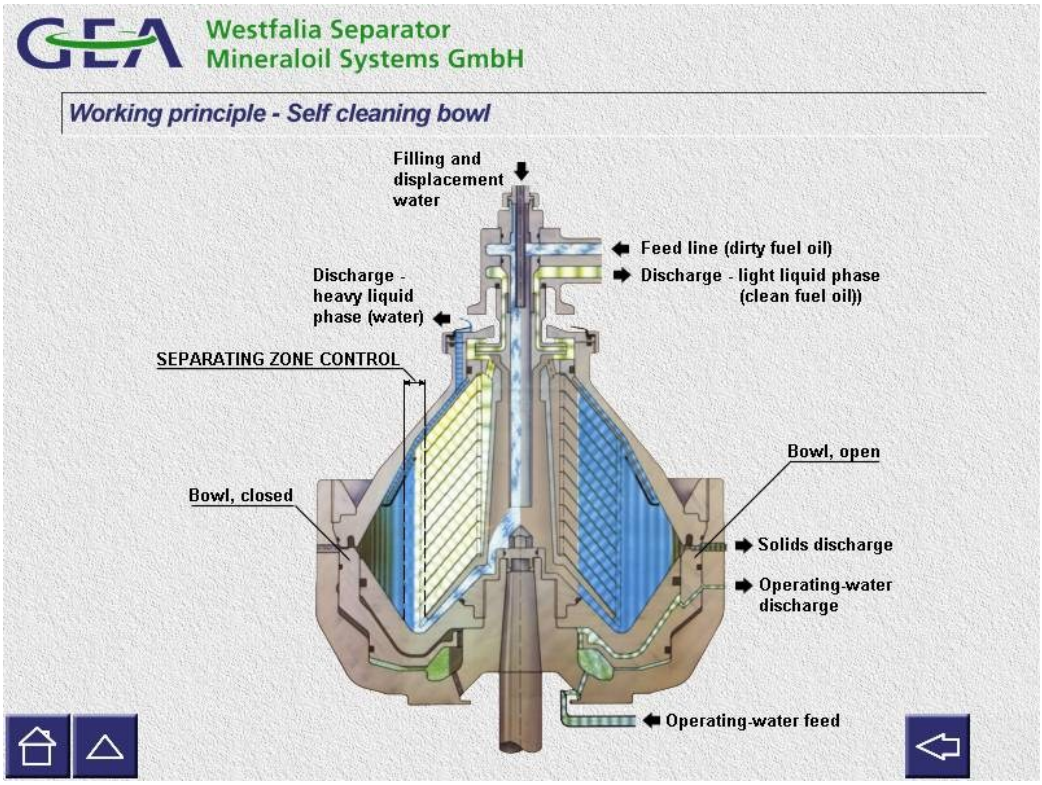
1) Description

   a) application
   b) working principle
   c) UNITROL system's description
   d) SECUTROL system's description
   e) main components
   f) pictures

2) Operating

   a) preparation for starting a single separator
   b) preparation for starting a series operation
   c) stopping separator
   d) automatic control functioning
   e) operating stages

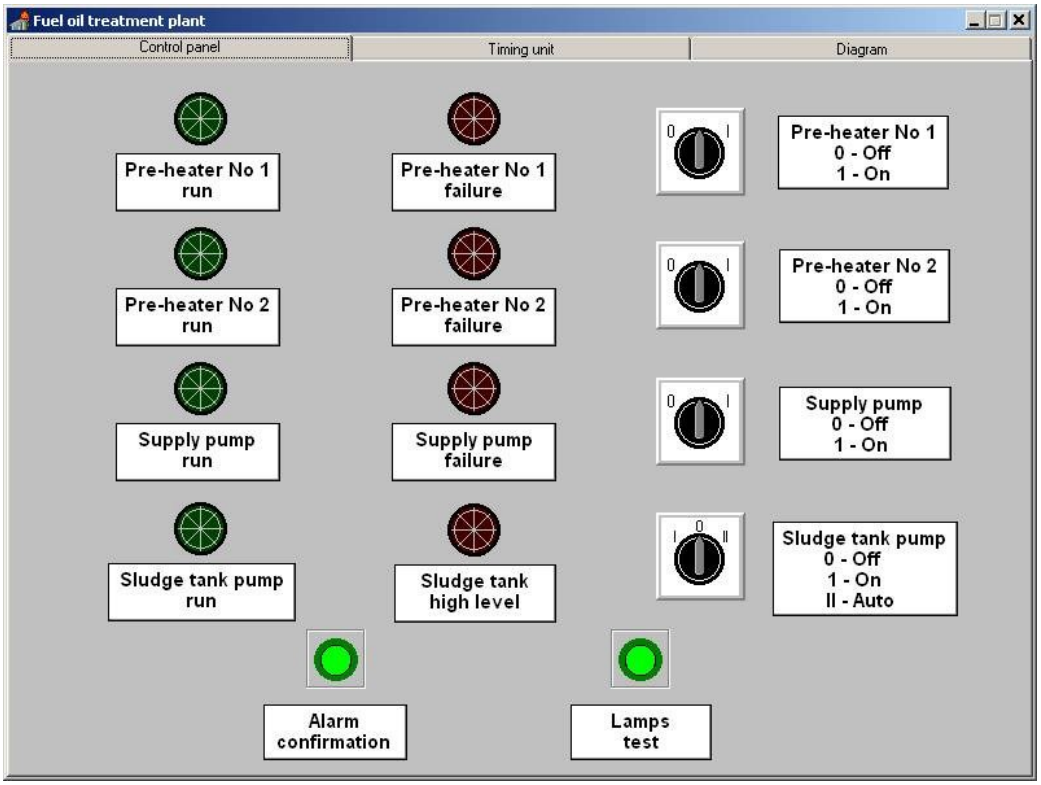
3) Test

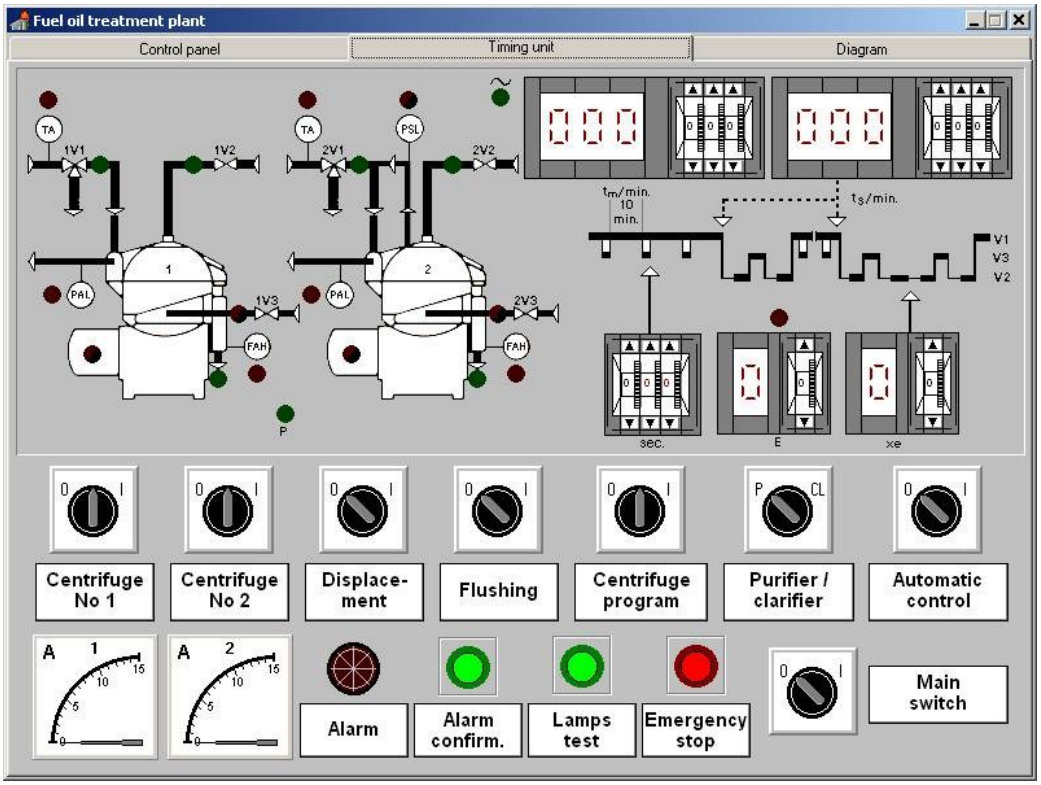

Westfalia Separator
Mineraloil Systems GmbH
Working principle - Self cleaning bowl
Filling and displacement water
Feed line (dirty fuel oil)
Discharge - light liquid phase (clean fuel oil))
Discharge - heavy liquid phase (water)
SEPARATING ZONE CONTROL
Bowl, open
Bowl, closed
Solids discharge
Operating-water discharge
Operating-water feed

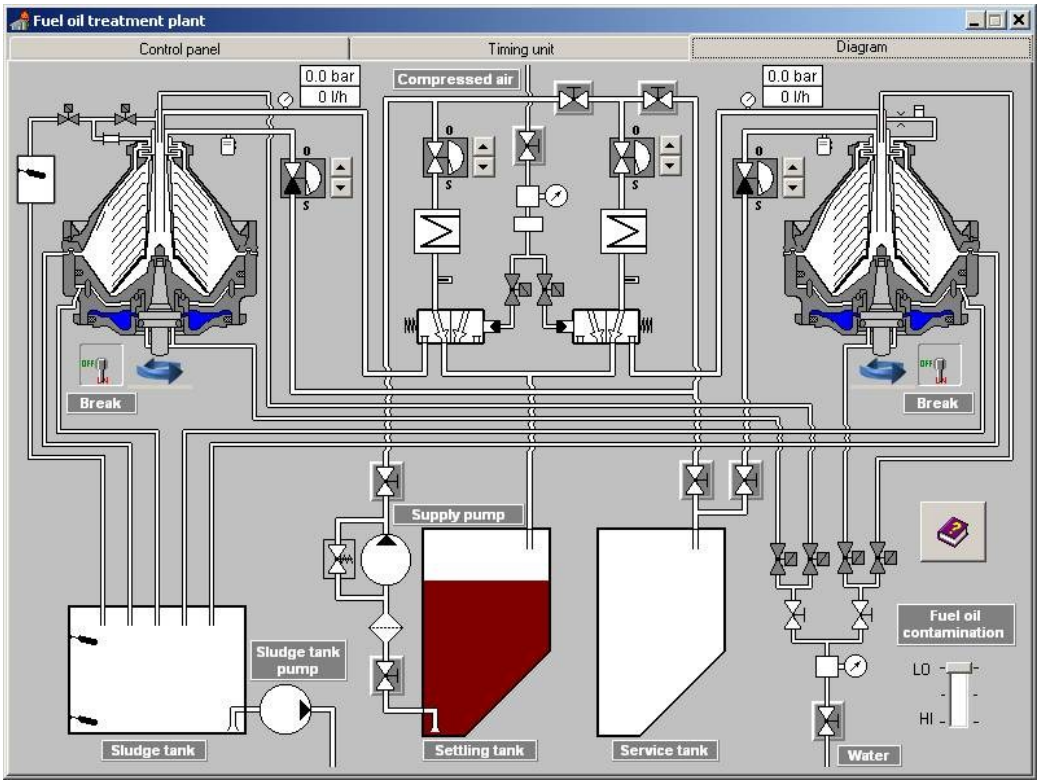
Westfalia Separator
Mineraloil Systems GmbH
Application
Centrifugal separators OSA type ( centrifuges ) are used for the separation of liquid mixtures or for the separation of solids out of liquids or liquid mixtures.
Fuel treatment plant consists of two centrifuges:
- centrifuge 1 - UNITROL system for purification
- centrifuge 2 - SECUTROL system for clarification
Centrifuge UNITROL can work on single or series operation ( two-stage separation UNITROL -SECUTROL ).

The **simulator program** consists of the following parts:

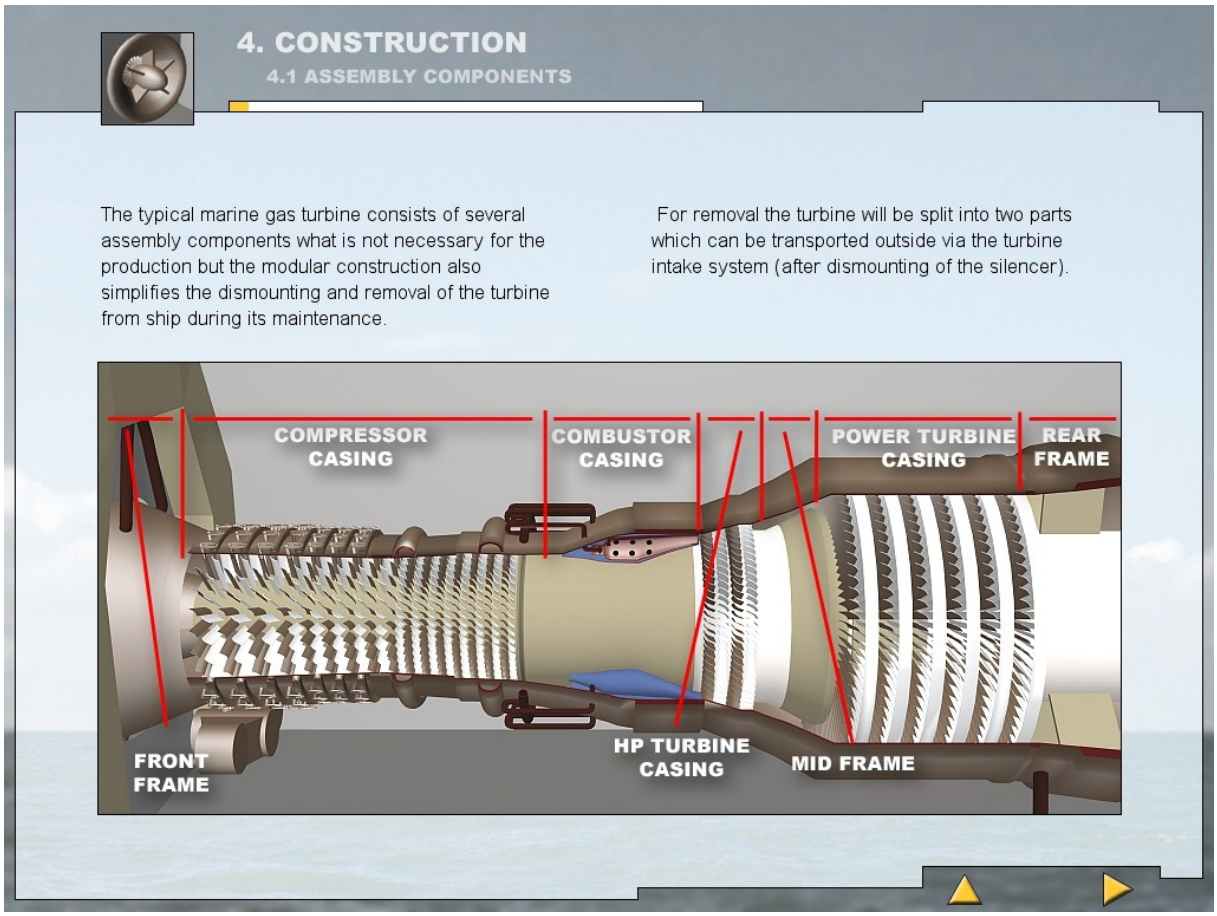
1) Control panel
2) Installation diagram
3) Timing unit




Fuel oil treatment plant
Control panel
Timing unit
Diagram
TA
1V1
1V2
2V1
2V2
PSL
PAL
FAH
1V3
2V3
P
sec.
E
xe
V1
V3
V2
Centrifuge No 1
Centrifuge No 2
Displace-ment
Flushing
Centrifuge program
Purifier / clarifier
Automatic control
Alarm
Alarm confirm.
Lamps test
Emergency stop
Main switch


Fuel oil treatment plant
Control panel
Timing unit
Diagram
0.0 bar
0 l/h
Compressed air
Break
Supply pump
Sludge tank pump
Sludge tank
Settling tank
Service tank
Fuel oil contamination
LO
HI
Water

# GAS TURBINE




The educational program **GAS TURBINE** describes the principles of a gas turbine operation, its theory basics and its construction. The program describes how does a gas turbine work, what are the main parts of it and explains the theoretical background of its operation. The special attention has been paid to the temperatures and the pressures observed in the typical gas turbine.

The **multimedia presentation** consists of main sections mentioned below:

1. Introduction

2. Working principles

    a. Cycle phases
    b. Pressure and temperature

3. Engine types

    a. Components of split-shaft engine
    b. Split-shaft engine

4. Construction

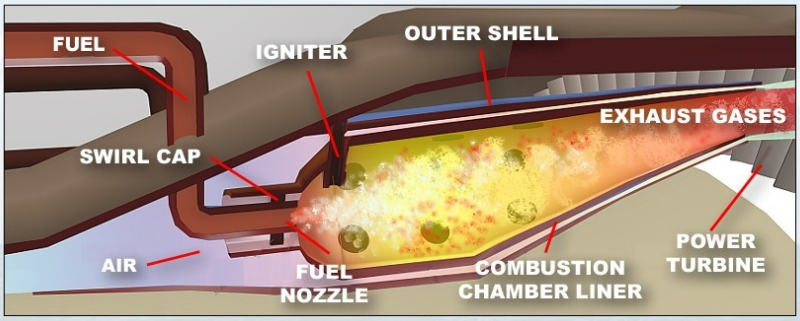
    a. Assembly components
    b. Split-shaft engines
    c. Compressor
    d. Combustor
    e. HP turbine
    f. Power turbine
    g. Intake duct
    h. Intake plenum
    i. Inlet duct
    j. Cooling inlet
    k. Anti-icing system
    l. Inlet silencer
    m. Flexible intake joint
    n. Engine enclosure
    o. Exhaust system
    p. Exhaust elbow
    q. Flexible exhaust joint
    r. Exhaust duct
    s. Exhaust silencer
    t. Stack

## 4. CONSTRUCTION

### 4.4 COMBUSTOR

The main task of the combustor is to burn the fuel (delivered by the fuel nozzle in a form of the spray) with the air. The air is compressed by a compressor and is used not only for the combustion but also for the external cooling of the combustion chamber liner where the combustion takes the place.
The combustor is responsible not only for the combustion of the fuel but also for the exhaust gases cooling down.

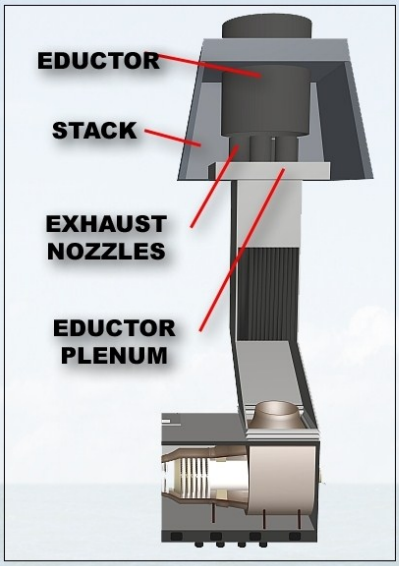
The temperature of the exhaust gases can not be to high because of the durability of the HP turbine vanes and blades. Because of that only ca. 30% of the air delivered by a compressor is used for the combustion and the remaining 70% is used for the combustion liner cooling. The typical combustor has 30 fuel nozzles and 2 igniters.




## 4. CONSTRUCTION

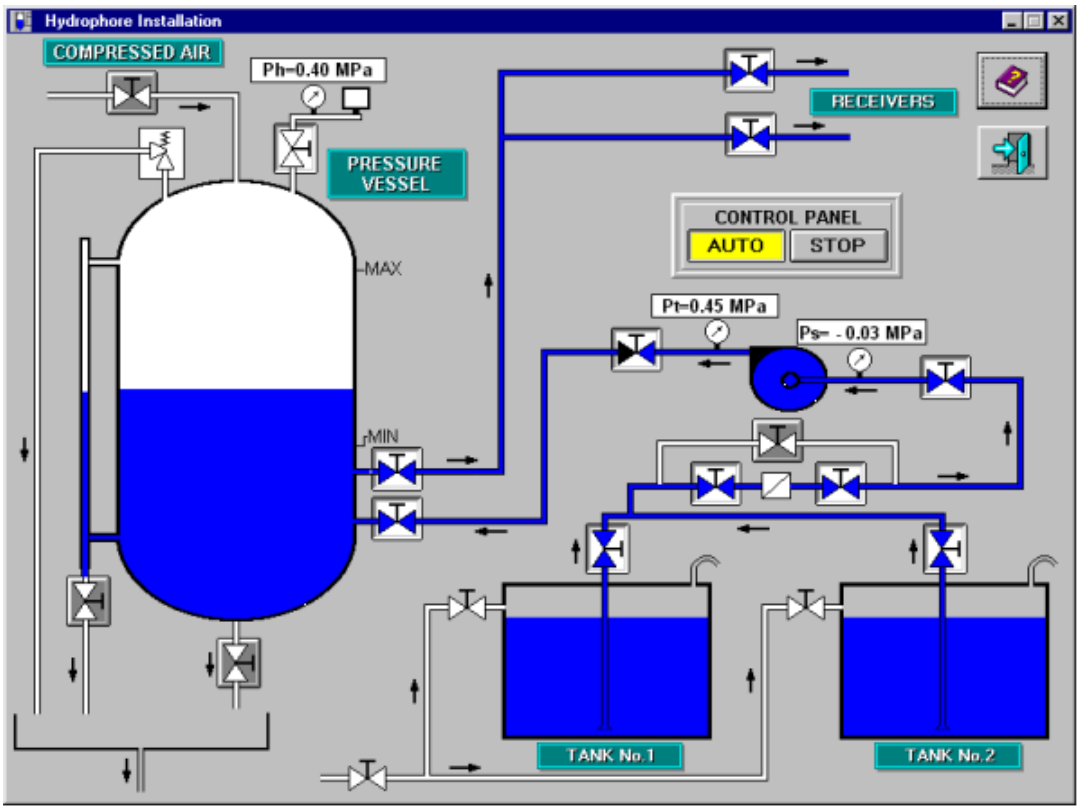
### 4.20 STACK

The stack has a complicate construction because its secondary role is to cool-down the exhaust gases. Exhaust eductors are located at the uppermost end of the exhaust ducting. Exhaust eductors cool the exhaust gases by mixing with cool ambient air to reduce the infrared signature of the ship. Exhaust gas temperature may be further reduced by an IR reduction system.



# HYDROPHORE INSTALLATION

The educational program **HYDROPHORE INSTALLATION** is intended for teaching the basic principles of how to operate a typical hydrophore installation for sanitary water used in marine power plant.

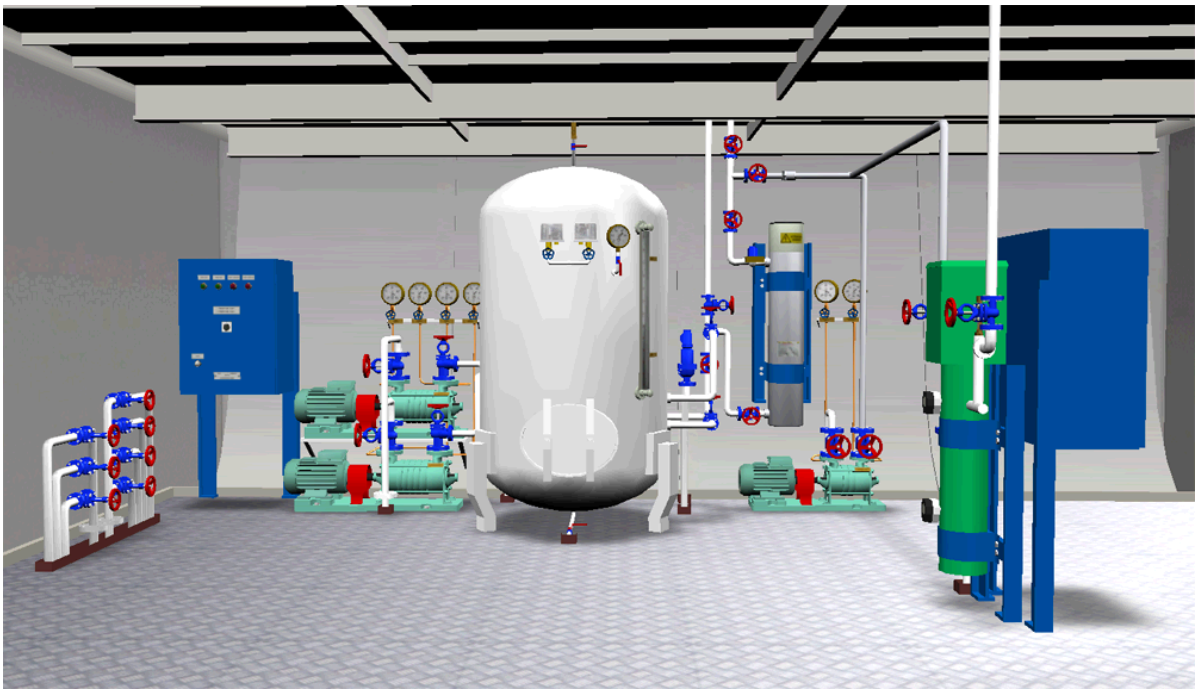


# HYDROPHORE INSTALLATION 3D

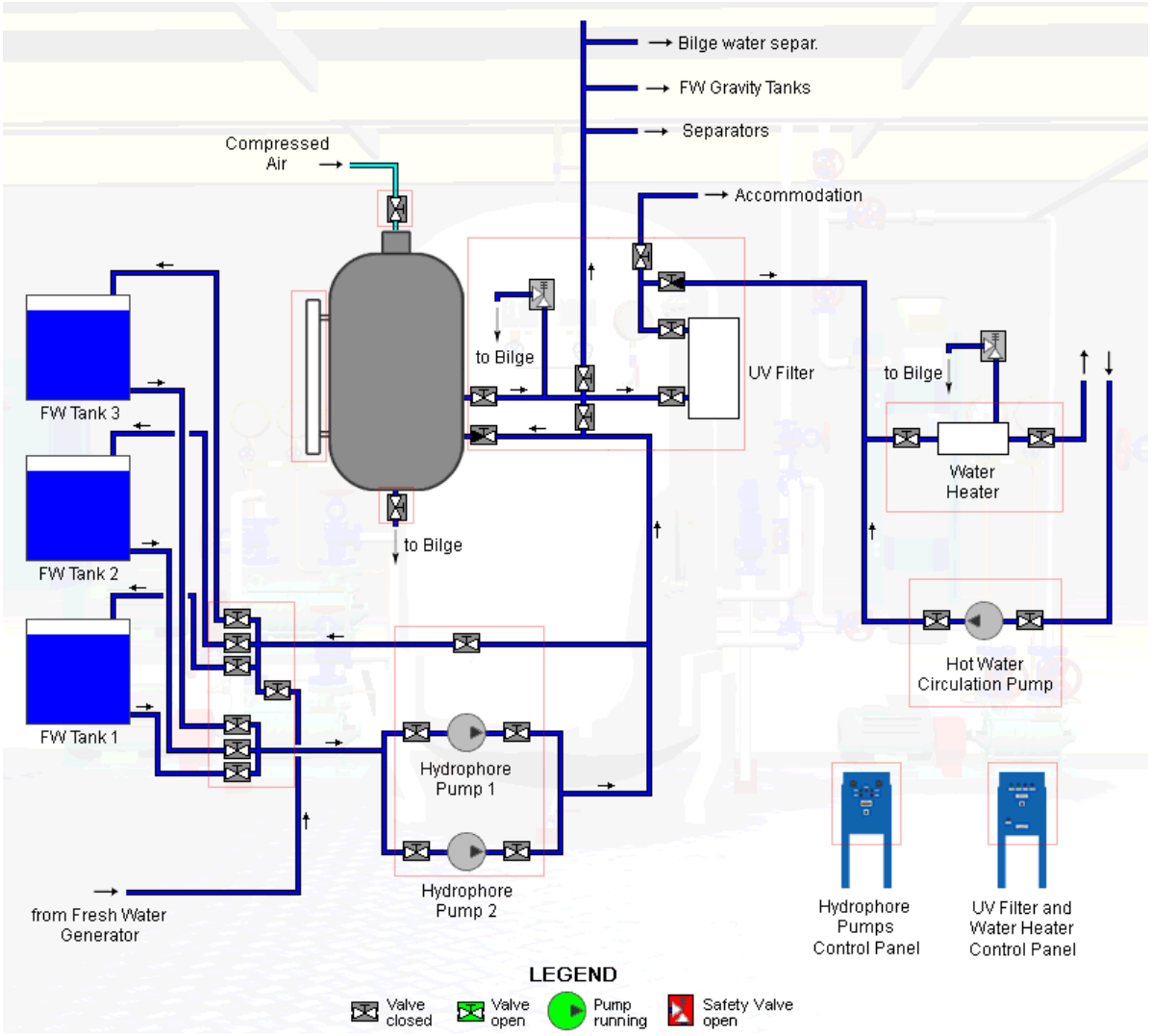
The educational program **HYDROPHORE INSTALLATION 3D** is intended for teaching the basic principles of how to operate a typical hydrophore installation for sanitary water used in marine power plant.

The simulator consists of the following elements:

1. Pressure vessel / hydrophore / provided with the following fittings:
   - pressure gauge
   - differential pressure control with cut-off valve
   - water level glass
   - compressed air system connection
   - safety valve
   - drain valves (release extraction)
   - inlet and outlet valves
2. Water pumps
3. Water tanks No 1 and No 2 and No 3
4. UV sterilizer
5. Hot water circulation pump
6. Hot water heater



The simulator diagram shows the basic configuration of freshwater generator and status of main element and valves. Basic parameters of the system are also presented.



# MARINE DIESEL ENGINE MONITORING SYTEMS

The **MARINE DIESEL ENGINE MONITORING SYSTEM** program describes the diagnostic systems destinated for the analysis of Diesel engine combustion and injection process.

The program includes the presentation of both stationary and portable monitoring systems for continuous and periodical application.

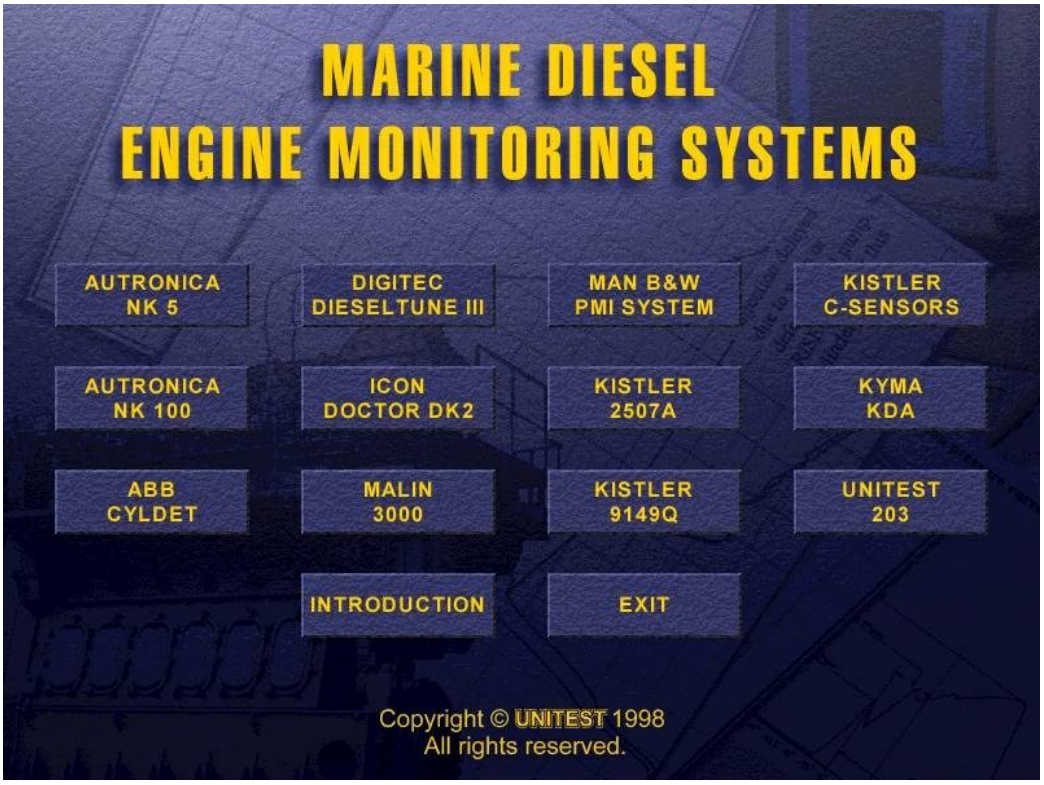
The program presents the solutions regarding monitoring systems being actually used on ships.

The program consists of a general introduction and description of the following systems:

1) AUTRONICA NK5
2) AUTRONICA NK100
3) ABB CYLDET
4) DIGITEC DIESELTUNE III
5) ICON DOCTOR DK2
6) MALIN 3000
7) MAN B&W PMI SYSTEM
8) KISTLER 2057A
9) KISTLER 9149Q
10) KISTLER C- SENSORS
11) KYMA KDA
12) UNITEST 203

The parts related to the systems AUTRONICA NK5, AUTRONICA NK100, DIGITEC DIESELTUNE III includes examples of faults on combustion and injection pressure.

UNITEST –203 contains the demo of the diagnostic system operation.


MARINE DIESEL
ENGINE MONITORING SYSTEMS
AUTRONICA NK 5
DIGITEC DIESELTUNE III
MAN B&W PMI SYSTEM
KISTLER C-SENSORS
AUTRONICA NK 100
ICON DOCTOR DK2
KISTLER 2507A
KYMA KDA
ABB CYLDET
MALIN 3000
KISTLER 9149Q
UNITEST 203
INTRODUCTION
EXIT
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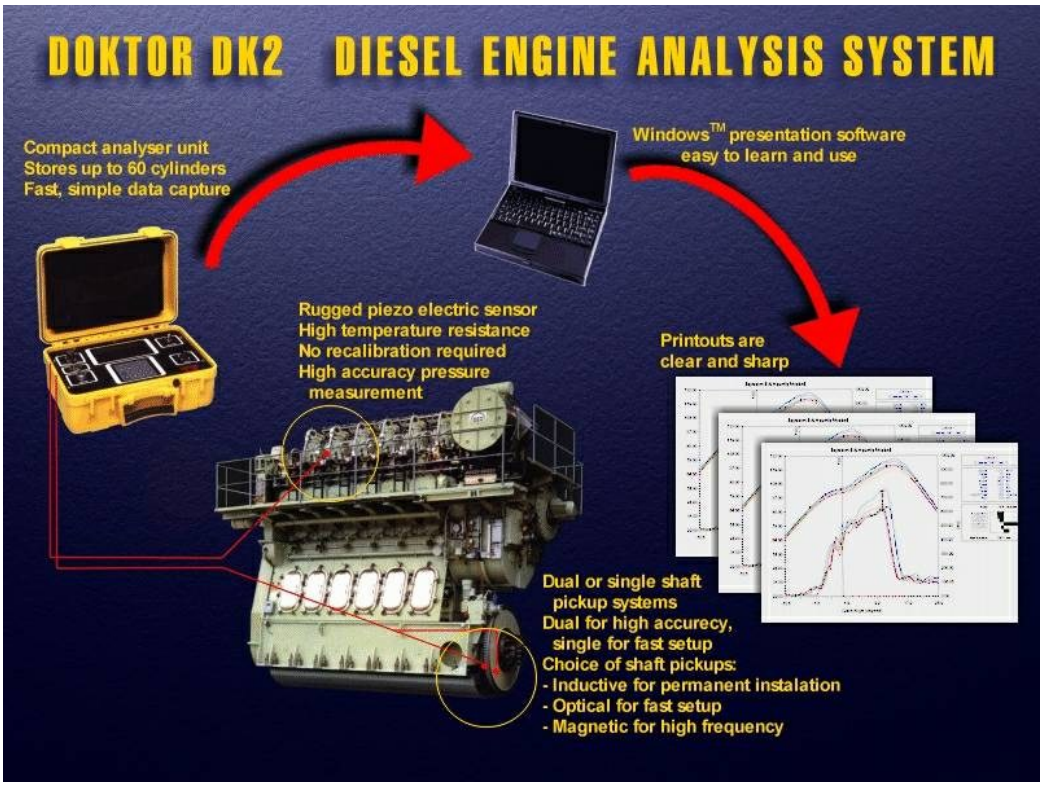
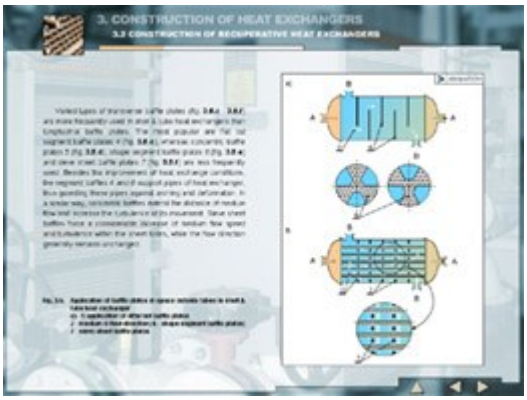
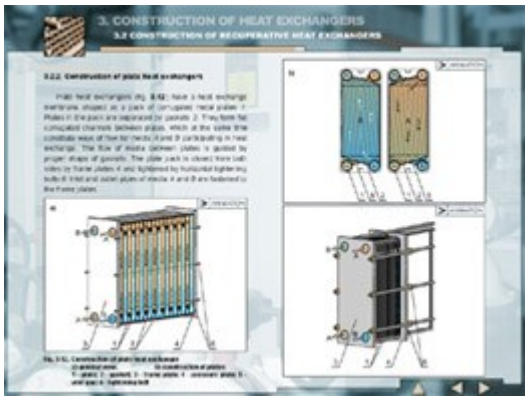

DOKTOR DK2 DIESEL ENGINE ANALYSIS SYSTEM
Compact analyser unit
Stores up to 60 cylinders
Fast, simple data capture
Windows™ presentation software
easy to learn and use
Rugged piezo electric sensor
High temperature resistance
No recalibration required
High accuracy pressure measurement
Printouts are clear and sharp
Dual or single shaft pickup systems
Dual for high accurecy, single for fast setup
Choice of shaft pickups:
- Inductive for permanent instalation
- Optical for fast setup
- Magnetic for high frequency

# MARINE HEAT EXCHANGERS




The educational program **MARINE HEAT EXCHANGERS** is intended for teaching the construction and working principles of a typical central cooling water system.

The program consists of two main parts:

1. Multimedia presentation
2. Simulator

The **multimedia presentation** part of the program consists of main sections mentioned below:

5. Classification of marine heat exchangers.

6. Basics of heat exchangers

    a. Basic processes of heat exchange
    b. Combined processes of heat exchange
    c. Directions of media flow during heat exchange process

7. Construction of heat exchangers

    a. Construction of direct-contact heat exchangers
    b. Construction of recuperative heat exchangers
    c. Construction of regenerative heat exchangers

8. Central Cooling Water System - system elements with description.

9. Assessment - questions about the theory and the practice in the skill test.

The **Central Cooling Water System simulator** consists of three circuits:

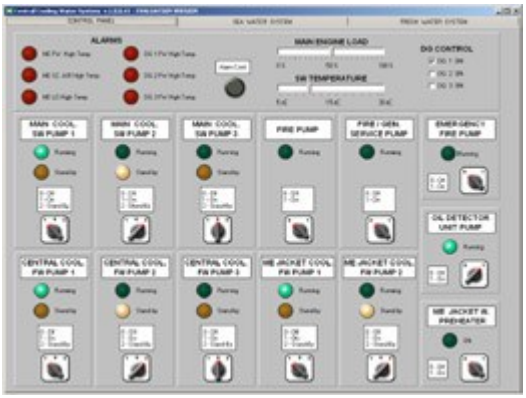
- seawater
- low temperature freshwater for central cooling
- high temperature freshwater for ME jacket cooling

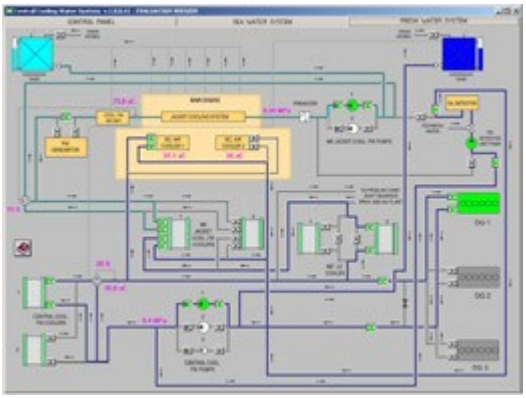
In the central cooling system only one heat exchanger is cooled by seawater. All other heat exchangers are freshwater cooled and therefore, they can be made of a less expensive material.

The Central Cooling Water System Simulator is divided into 2 sub-systems: freshwater and seawater. The seawater sub-system is responsible for the freshwater cooling. The freshwater sub-system is responsible for the ME jacket, piston and injector cooling, as well as scavenge air and the diesel generators.

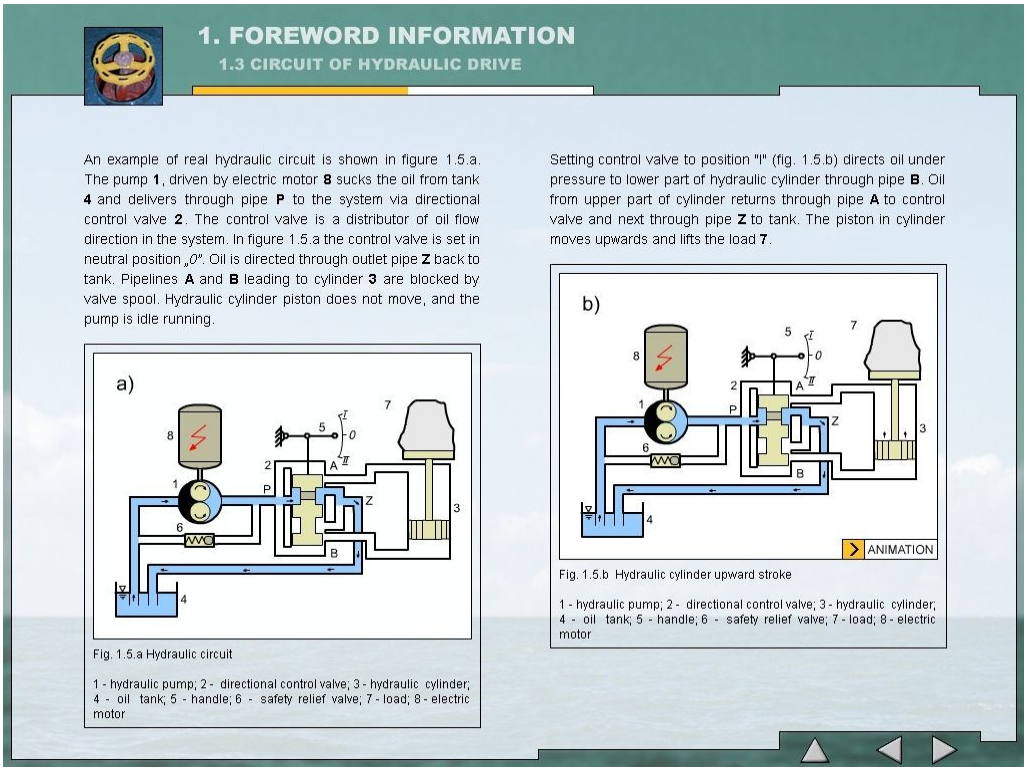
The simulator consists of the following parts:

- Control Panel
- Sea Water System
- Fresh Water System





# MARINE HYDRAULIC MACHINERY




The educational program **MARINE HYDRAULIC MACHINERY** is intended for teaching the construction and working principles of a typical marine hydraulic machinery.

The program includes only a **multimedia presentation** which consists of main sections mentioned below:

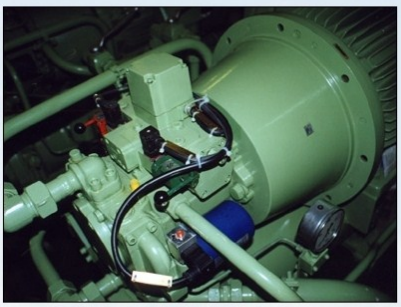
1. Forward information.
2. Graphical symbols in hydraulics.
3. Components in hydraulic systems.
4. Types of hydraulic circuits.
5. Control of operating speed in hydraulics.
6. Examples of marine hydraulic machinery.
7. Hydraulic oils.
8. Assessment.

## 3. COMPONENTS OF HYDRAULIC SYSTEMS
### 3.1 HYDRAULIC PUMPS

Hydraulic pumps are the source of energy in hydraulic system. Pumps convert mechanical energy delivered by driving motor into hydraulic energy of working oil, which is supplied to the system under proper pressure and capacity.

Hydraulic systems require supply with oil in high pressure and uniform flow rate (without pulsation). Positive displacement rotary pumps possess such feature of delivery i.e. vane, gear and screw type as well as radial and axial multipiston pumps of constant and variable displacement.

Rotary pumps achieve working pressure up to *30 MPa*, and multipiston pumps even to *70 MPa*. The capacity of hydraulic pumps depends on their size and may amount from a dozen to several thousand $dm^3$/min, when revolutions are from several hundred to several thousand *rpm*.



## 3. COMPONENTS OF HYDRAULIC SYSTEMS
### 3.1 HYDRAULIC PUMPS

***Internal gear pump*** shown in figure 3.6 is characterised by lower noise level when running, quieter suction process, lower pulsation of liquid stream and more compact design than external gear pump. Driving rotor 2 is fixed on driving shaft 4 and mounted inside internally toothed driven rotor 3. During processes of medium suction and discharge the co-operation of rotors is analogous to the same as in external gear pump. Since rotors have different diameters, after the suction process is completed, voids between teeth in both impellers where the medium is transferred are to be sealed. Crescent segment 5 is used for this purpose. Inlet port to the suction zone of rotors 6 and outlet port from discharge zone 7 are placed in the side cover of housing.

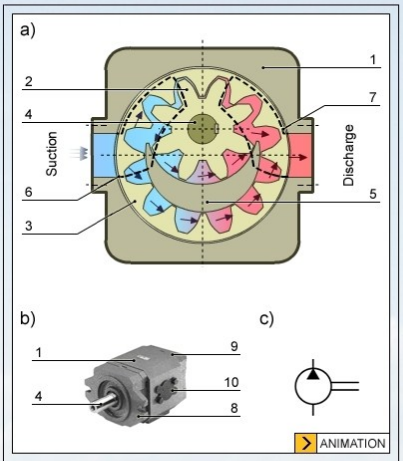



Fig. 3.6. Internal gear pump
a) section, b) general view, c) graphical symbol
photo from REXROTH Hydraulics. Basic Principles and Components
1 - housing; 2 - driving rotor (active); 3 - driven rotor (passive); 4 - driving shaft; 5 - crescent segment; 6 - inlet port; 7 - outlet port; 8 - front cover; 9 - rear cover; 10 - outlet connector

# MARINE PUMPS

The educational program **MARINE PUMPS** is intended for teaching the basic principles of how to operate a typical water pumps installation used in marine and industrial power plants.

The program is based on an installation with two centrifugal pumps. Each of the pumps can function either individually either in parallel or serial operation.

The program consists of two main parts:

- Multimedia presentation
- Simulator

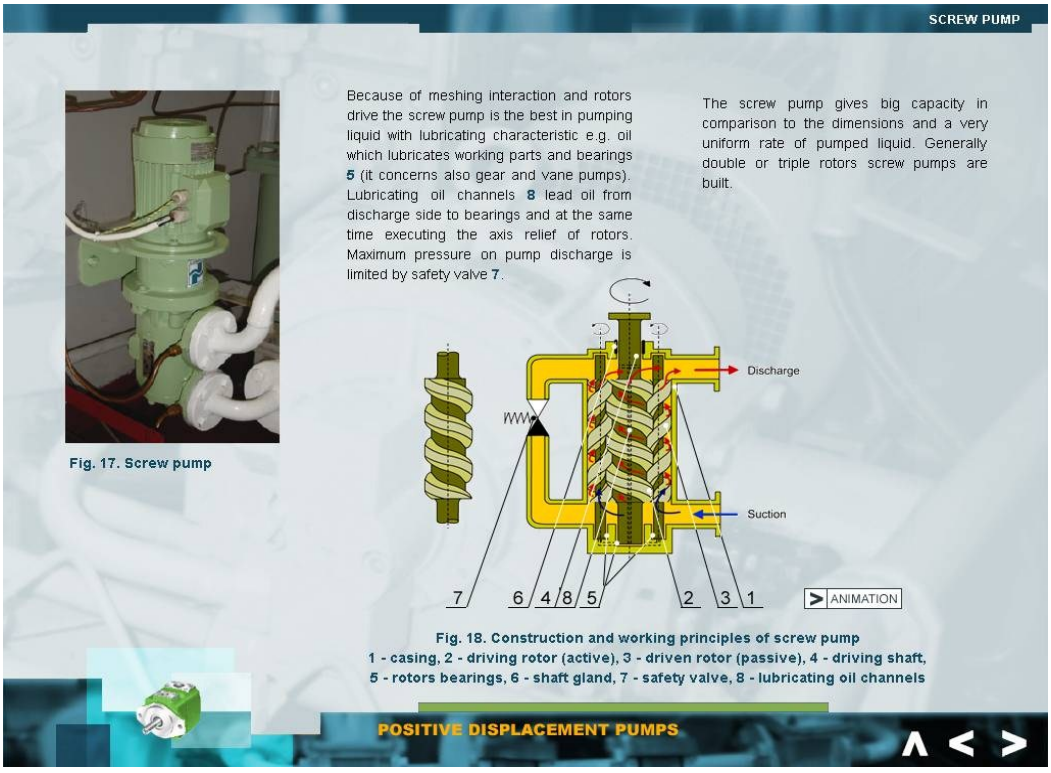



Fig. 17. Screw pump

Fig. 18. Construction and working principles of screw pump
1 - casing, 2 - driving rotor (active), 3 - driven rotor (passive), 4 - driving shaft, 5 - rotors bearings, 6 - shaft gland, 7 - safety valve, 8 - lubricating oil channels

The multimedia presentation part of the program consists of main sections mentioned below:

1. Definition and classification of marine pumps.

    a) Definition
    b) Classification of marine pumps

2. Positive displacement pumps.

    a) Characteristic features of positive displacement pumps
    b) Classification of positive displacement pumps
    c) Construction and working of positive displacement pumps
        - Plunger pump
        - Piston pump
        - Membrane pump
        - Variable displacement multipiston radial pump with rotating cylinders
        - Variable displacement multipiston axial pump with rotating cylinders
        - Swing pump
        - Sliding-vane pump
        - Gear pump
        - Screw pump
        - Single rotor screw pumps

3. Rotodynamic (impeller) pumps.

    a) Characteristic features of rotodynamic (impeller) pumps
    b) Classification of rotodynamic (impeller) pumps
    c) Construction and working of rotodynamic (impeller) pumps
        - Centrifugal pump
        - Parabolic flow pump
        - Diagonal flow pump
        - Axial flow (propeller) pump
        - Circulating pump with side ring channels
        - Circulating pump with rotating liquid ring

4. Jet pumps.

    a) Characteristic features of jet pumps (eductors)
    b) Classification of jet pumps (eductors)
    c) Construction and working of jet pumps (eductors)
        - Eductor

5. Operating procedures.

6. Assessment - some questions about the theory and the practice in the skill test.

CIRCULATING PUMP WITH SIDE RING CHANNELS

When the channel ends the space between the blades decreases and liquid is thrown into discharge port **8** placed nearby. Increased and decreased working space due to liquid movement in side channels causes the self-suction ability of pump. It is a very important operation feature, which is not possessed by angular momentum pumps. The liquid circulation described above is the decisive moment in pump operation. Yet the efficiency of pump is lower then in the angular momentum pumps. When pump is stopped the liquid remains inside casing due to upside direction of pipe connectors and a non-return valve mounted on outlet pipe. In this way during the next start priming is not necessary.

Driving motor is directly coupled with the shaft **3** fitted with impeller **2**. The shaft is laid in bearings **4** and sealed in casing by ring **5**.

The two-stage pump is shown in the drawing i.e. two stages operating in a series connection. Each stage works in accordance with the above-mentioned description. Discharge of liquid from the first stage is guided to the second stage suction port. In this way the higher pressure on pump outlet is obtained.

Fig. 7. Circulating pump with side ring channels

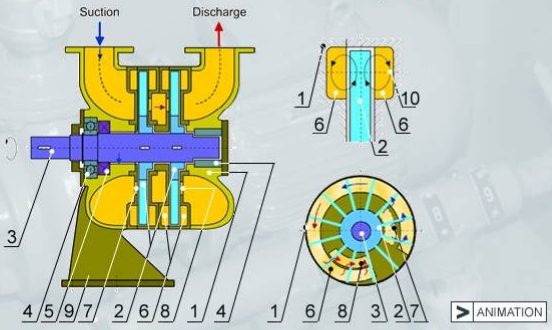



Fig. 8. Construction and working principles of circulating pump with side ring channels
1 - casing, 2 - impeller with blades, 3 - shaft, 4 - bearings, 5 - sealing ring,
6 - ring chanels, 7 - suction port, 8 - discharge port, 9 - fundation, 10 - liquid circulation

ROTODYNAMIC (IMPELLER) PUMPS

CONSTRUCTION AND WORKING PRINCIPLES OF JET PUMPS (EDUCTORS)

## Construction and working principles of jet pumps (eductors)

**Eductor** (jet pump – **Fig. 2**) has a very simple construction and no moving parts when working. This is its basic advantage. The pump is motivated by a stream of motive medium supplied through connector **6** to nozzle **1**. Air (gas), water or steam can be used as motive medium. It leaves nozzle with high speed, which results in arising of vacuum in suction chamber **2**. Due to this the liquid suction from suction connector **4** occurs.

In chamber **2** both media mix and flow into diffuser **3**. It has a widening shape, which causes conversion of mixture kinetic energy into the potential energy (pressure). Under suitable pressure the mixture of the pumped liquid and the motive medium is discharged into outlet pipe system through discharge connector **5**.

Jet pump (eductors) can transfer gases, fluids and loose materials. The disadvantage of pump is mixing of motive medium with pumped medium. It limits the use of jet pump to systems allowing such a situation.

Jet pumps (eductors) used for production of vacuum or pumping from negative pressure spaces to atmospheric pressure are called ejectors. Jet pumps discharging into spaces of pressure higher than atmospheric are named injectors.

Fig. 1. Jet pump (eductor)

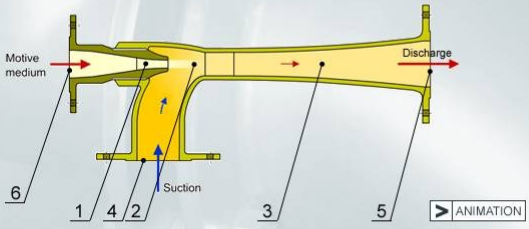
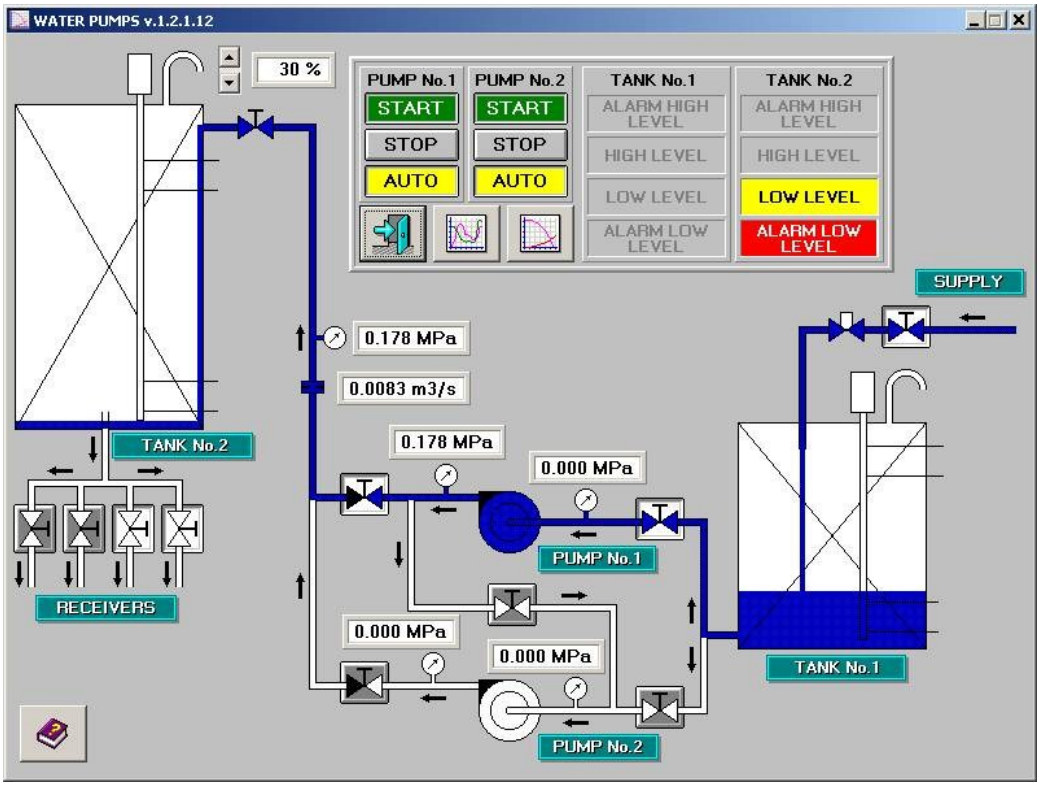


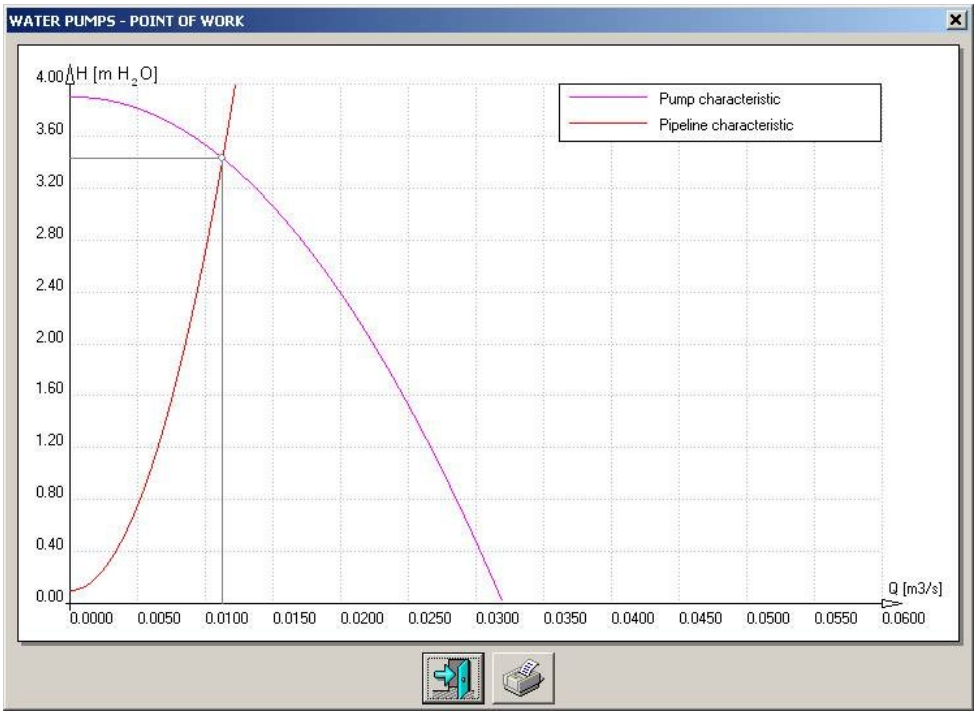

Fig. 2. Construction and working principles of jet pump (eductor)
(1 - nozzle, 2 - suction chamber, 3 - diffuser, 4 - suction connector,
5 - discharge connector, 6 - motive medium inlet)

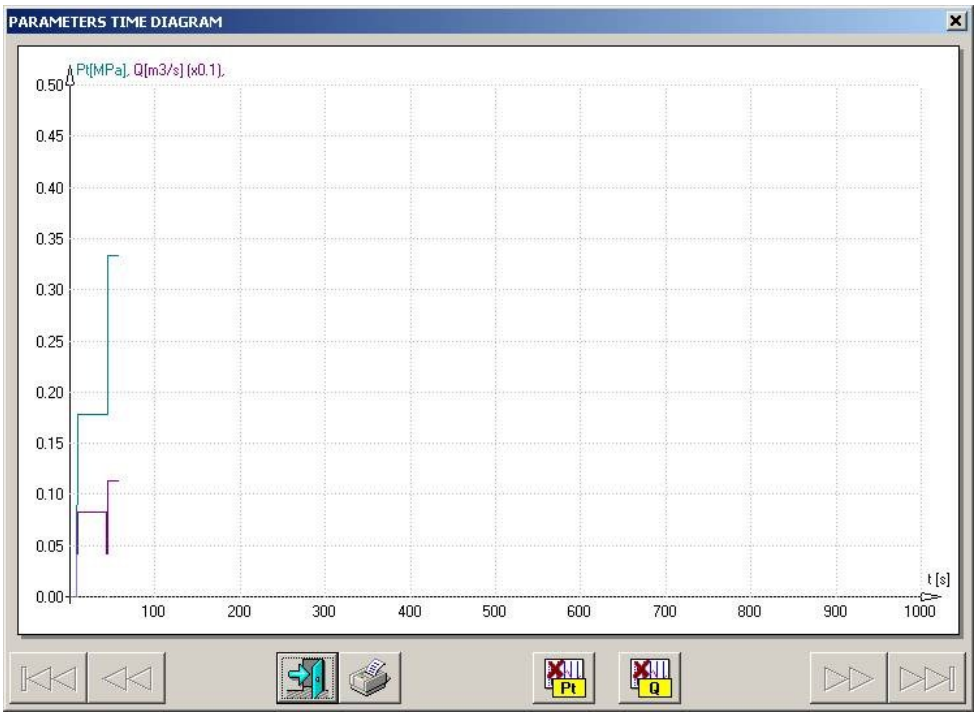
JET PUMPS

The **simulator program** is interactive i.e. it enable the realistic presentation of the Water Pumps System functioning. System reaction are identically as it happens during normal operations The simulator consists of the following parts:

- Control Panel
- System Diagram
- Pump and pipeline characteristic diagram
- Parameters time diagram




WATER PUMPS - POINT OF WORK
H [m H2O]
4.00
3.60
3.20
2.80
2.40
2.00
1.60
1.20
0.80
0.40
0.00
Pump characteristic
Pipeline characteristic
Q [m3/s]
0.0000
0.0050
0.0100
0.0150
0.0200
0.0250
0.0300
0.0350
0.0400
0.0450
0.0500
0.0550
0.0600


PARAMETERS TIME DIAGRAM
Pt[MPa], Q[m3/s] (x0.1),
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
t [s]
100
200
300
400
500
600
700
800
900
1000
Pt
Q

# MARINE COMPRESSORS

The educational program MARINE COMPRESSORS is intended for teaching the construction and working principles of a typical compressed air system.

The simulator is based on the compressor type HV2/200 (main air system), LL2/105 (control air system), HL2/77 (emergency air system) produced by Sperre Industri A/S.

The program consists of two main parts:

- Multimedia presentation
- Simulator

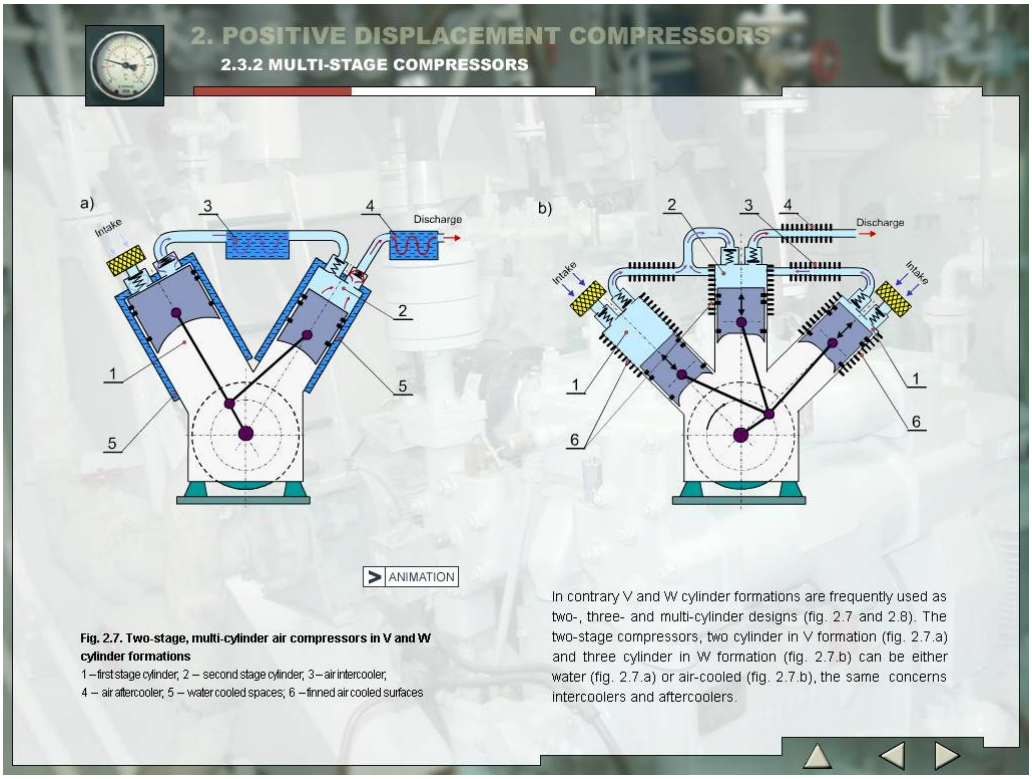



**Fig. 2.7. Two-stage, multi-cylinder air compressors in V and W cylinder formations**

1 – first stage cylinder, 2 – second stage cylinder, 3 – air intercooler, 4 – air aftercooler, 5 – water cooled spaces, 6 – finned air cooled surfaces

In contrary V and W cylinder formations are frequently used as two-, three- and multi-cylinder designs (fig. 2.7 and 2.8). The two-stage compressors, two cylinder in V formation (fig. 2.7.a) and three cylinder in W formation (fig. 2.7.b) can be either water (fig. 2.7.a) or air-cooled (fig. 2.7.b), the same concerns intercoolers and aftercoolers.

The **multimedia presentation** part of the program consists of main sections mentioned below:

1. Definition and classification of marine compressors

2. Positive displacement compressors
    a. Characteristic features
    b. Classification
    c. Piston compressors
    d. Multi-stage compressors
    e. Multi-cylinder compressors
    f. Rotary sliding vane compressors
    g. Rotary sliding screw compressors
    h. Cooling of positive displacement compressors
    i. Lubricating of positive displacement compressors

3. Rotodynamic compressors
    a. Characteristic features
    b. Classification
    c. Rotodynamic centrifugal compressors
    d. Rotodynamic diagonal flow compressors
    e. Rotodynamic axial flow compressors

4. Working principles – description of working cycle with formulas and interactive diagrams.

5. Compressed air system – system elements with description.

6. Assessment - questions about the theory and the practice in the skill test.

7. Operating instruction – simulator user's manual.

## 3. ROTODYNAMIC COMPRESSORS

### 3.3 ROTODYNAMIC CENTRIFUGAL COMPRESSORS

The special versions of turbine-driven centrifugal compressors, running with very high rotational speed, can achieve a compression ratio of σ = 5 - 6,5.
An example of one-stage rotodynamic centrifugal compressor is shown on the figure 3.2.
The compressor is arranged on foundation **5** by means of the elastic pads. The drive is executed by the electric motor **2** via gear transmission **3**.

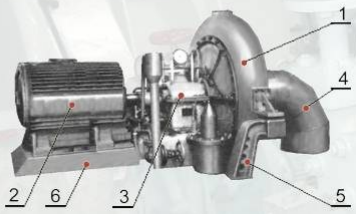
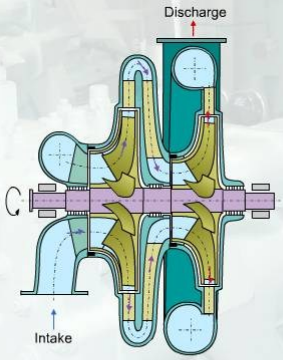



**Fig. 3.2. Rotodynamic centrifugal compressor unit**
(photo from brochure Pragoinvest Kompressoren CKD Praha)
1 – centrifugal compressor; 2 – electric motor; 3 – gear transmission;
4 – intake pipe; 5 – foundation leg; 6 – foundation

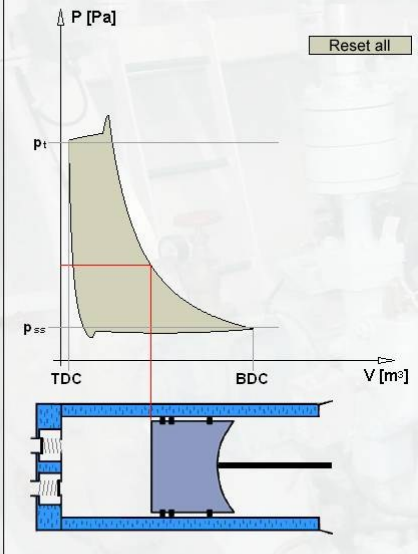
Figure 3.3 presents the construction of two-stage centrifugal compressor.

DESCRIPTION




## 4. WORKING PRINCIPLES

### 4.1 THE WORK PRINCIPLE OF THE PISTON COMPRESSOR




Clearance volume = 2117 mm³

Suction pressure = 0.101 MPa

Compression pressure = 0.700 MPa

Inlet duct resistance = 0.013 MPa

Outlet duct resistance = 0.035 MPa

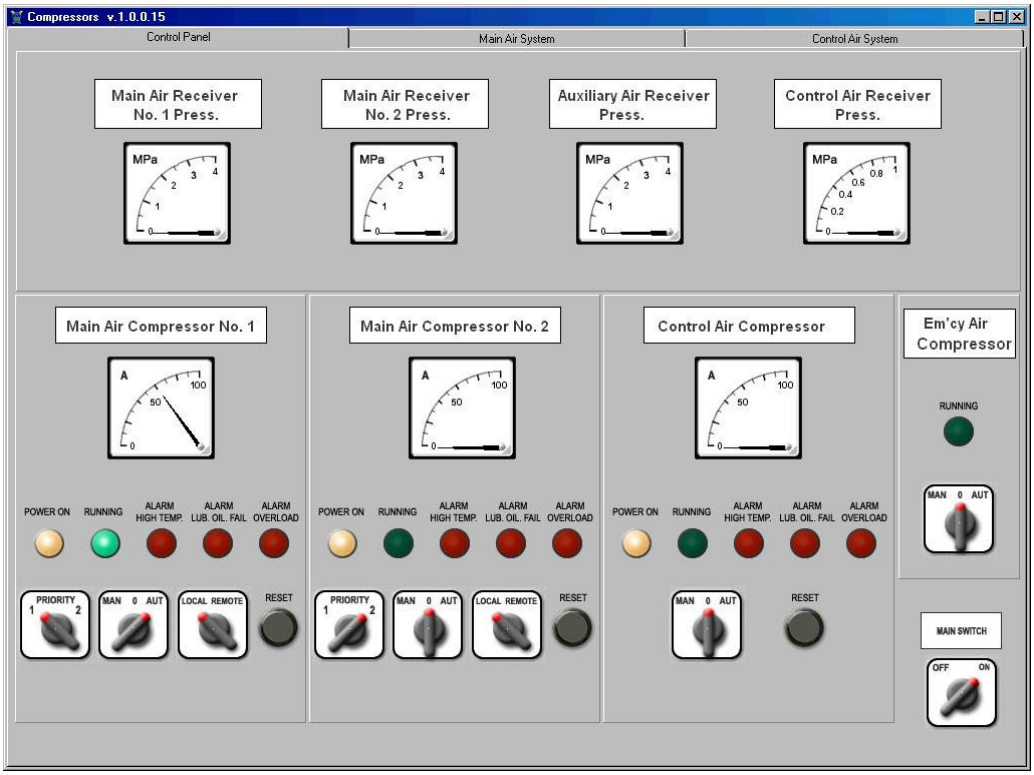
**Info:**

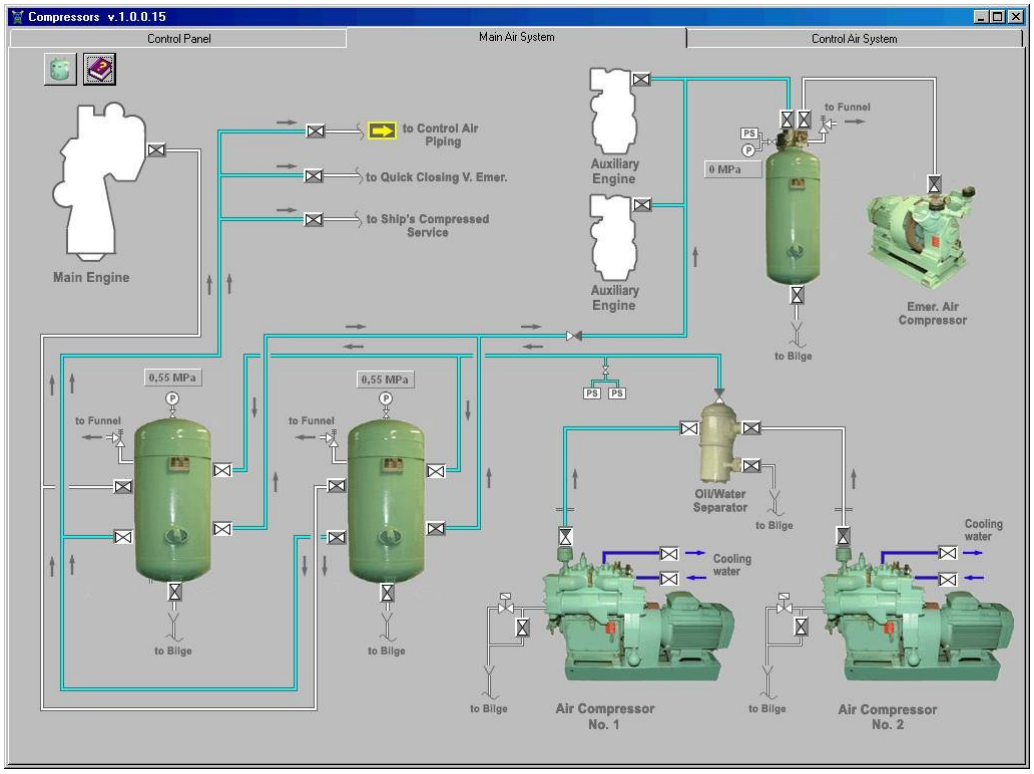
| | |
|---|---|
| D (cylinder diameter) | = 48 mm |
| S (piston stroke) | = 44 mm |
| Q (capacity) | = 105 $dm^3$/min |
| $N_e$(applied power) | = 1.54 kW |
| $P_d$(compression pressure) | = 0.7 MPa |
| rpm | = 1145 revs/min |

$p_s$ - suction pressure
$p_d$ - discharge pressure
$V_0$ - clearance volume
$V_s$ - displacement volume

The **Compressed air system simulator** consists of the following parts:

- Control Panel
- Main Air System
- Control Air System



# OILY WATER SEPARATOR

The educational program **OILY WATER SEPARATOR** is designated for learning the essential principles of the marine oil separation plant maintenance.

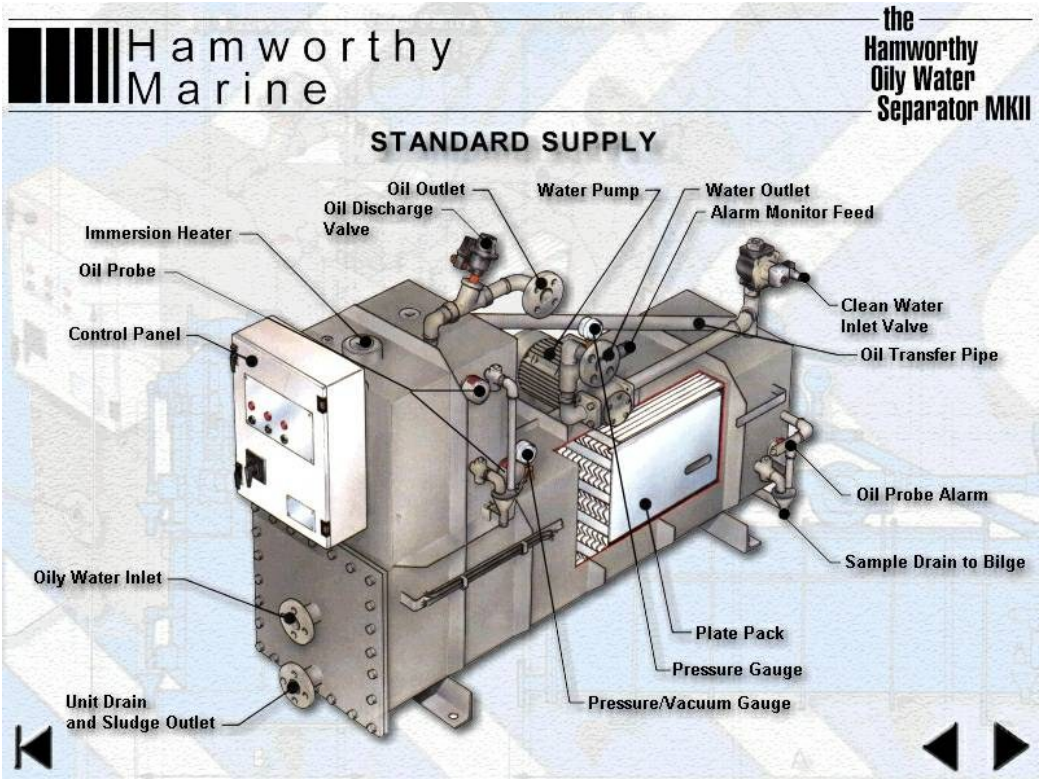
The program is based on typical marine oily water separator using the coalescing plate pack principle of separation.

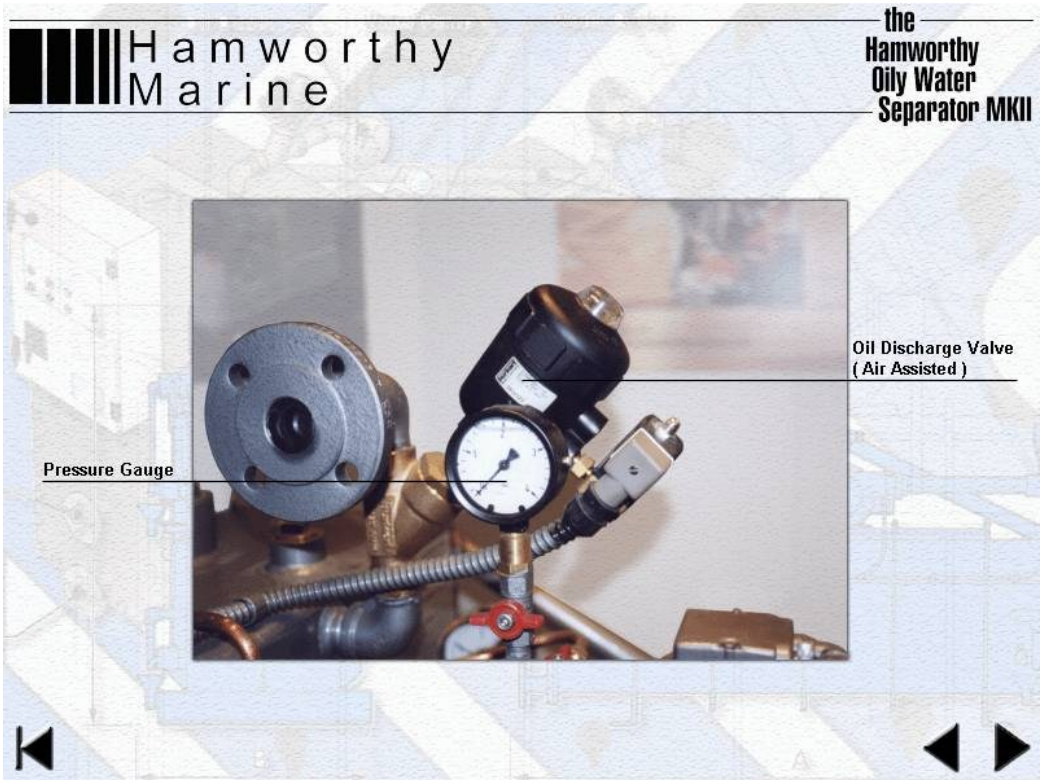
The program consists of two main parts:

- Multimedia presentation
- Simulator

The **multimedia presentation** part of the program consists of main sections mentioned below:

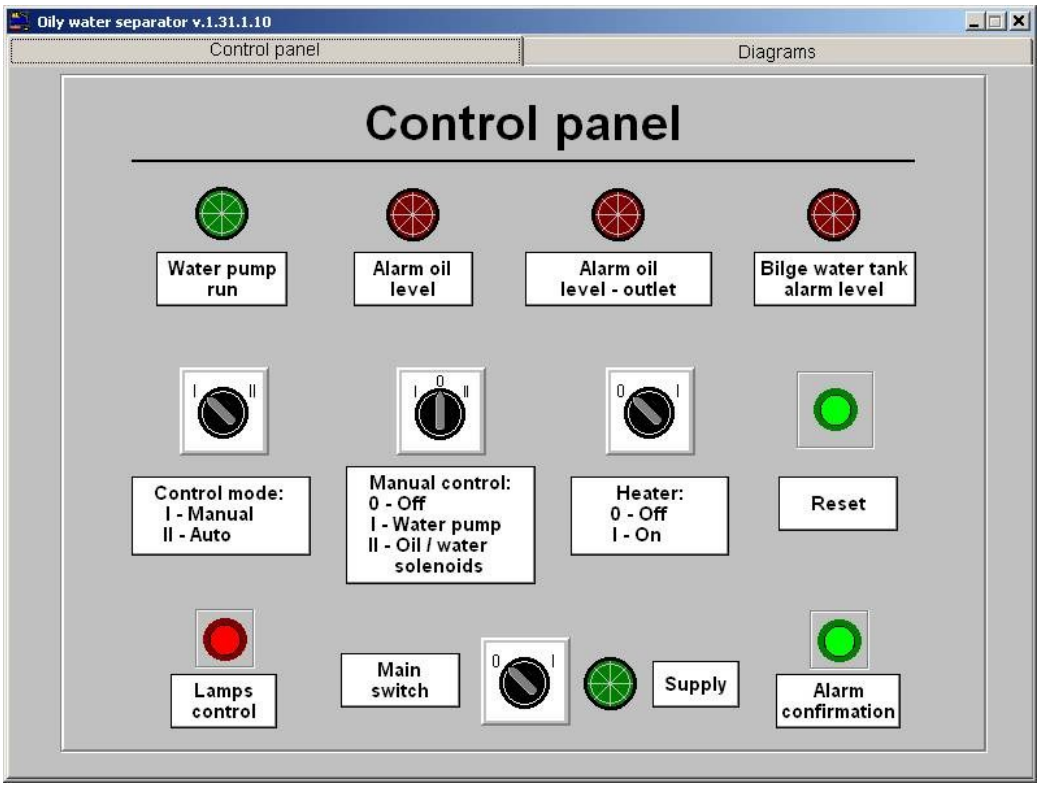
1) Description
2) Operating
3) Test

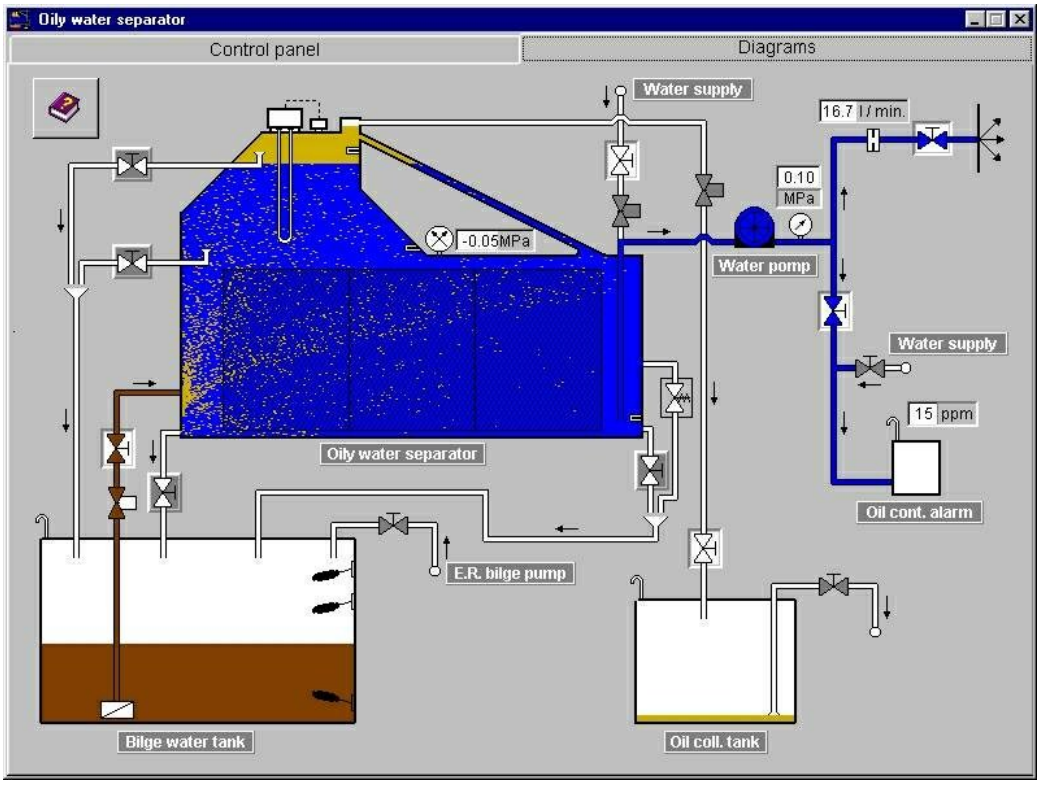

Hamworthy Marine
the Hamworthy Oily Water Separator MKII
STANDARD SUPPLY
Oil Outlet
Water Pump
Water Outlet
Oil Discharge Valve
Alarm Monitor Feed
Immersion Heater
Oil Probe
Clean Water Inlet Valve
Control Panel
Oil Transfer Pipe
Oil Probe Alarm
Sample Drain to Bilge
Oily Water Inlet
Plate Pack
Pressure Gauge
Unit Drain and Sludge Outlet
Pressure/Vacuum Gauge


Hamworthy Marine
the Hamworthy Oily Water Separator MKII
Oil Discharge Valve ( Air Assisted )
Pressure Gauge

The **simulator program** consists of the following parts:

1) Control panel
2) Installation diagram



# Refrigeration Plant

The educational program **REFRIGERATION PLANT - training simulator**, is designated for learning the essential principles of the refrigeration room maintenance. The program is based on a refrigerating plant with two cold chambers.

The program consists of two main parts:

- Multimedia presentation
- Simulator

The multimedia presentation part of the program consists of main sections mentioned below:

1. Basic parameters of the thermodynamic state

    a) General information and introduction
    b) Temperature
    c) Pressure
    d) Density and Specific volume
    e) Entropy

2. Thermodynamic of vapors / Fundamentals

    a) Fundamentals
    b) T-s diagram
    c) P-h diagram

3. Vapour-compression refrigeration cycle

    a) Refrigeration
    b) Reference vapour - compression cycles
    c) Basic parameters of the vapour-compression cycle
    d) Exemplary changes of the basic parameters of the vapour-compression cycle

4. Equipment

5. Main automatic controls and safety devices

6. Operating procedures

7. Assessment - some questions about the theory and the practice in the skill test

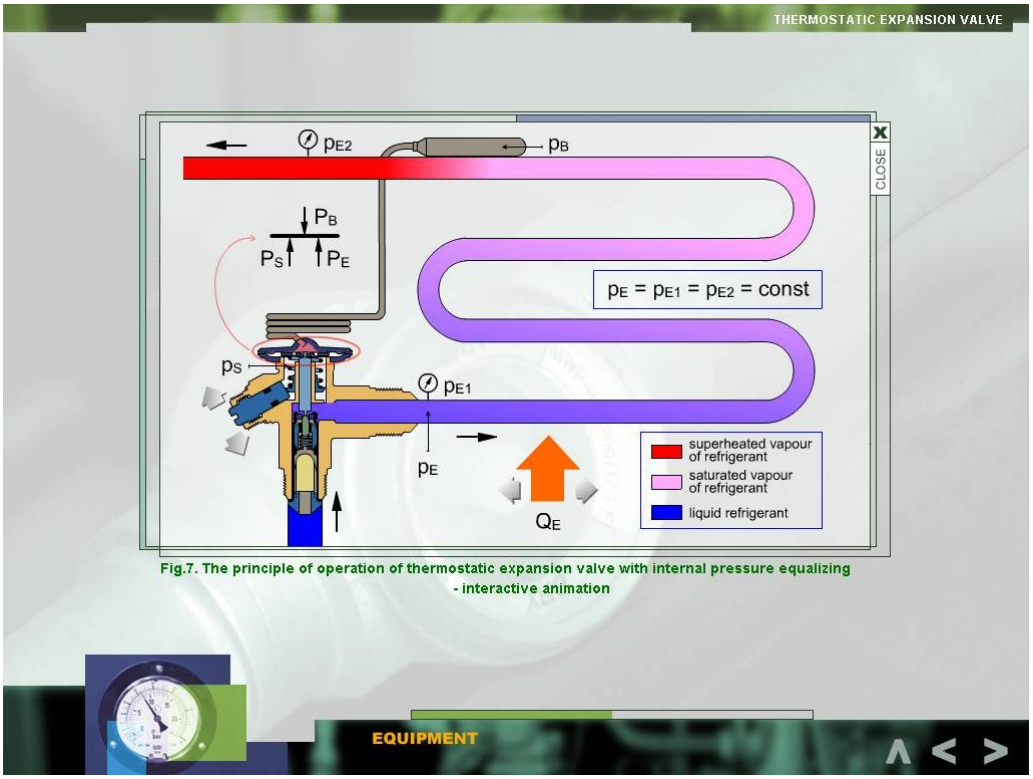



Fig.7. The principle of operation of thermostatic expansion valve with internal pressure equalizing - interactive animation

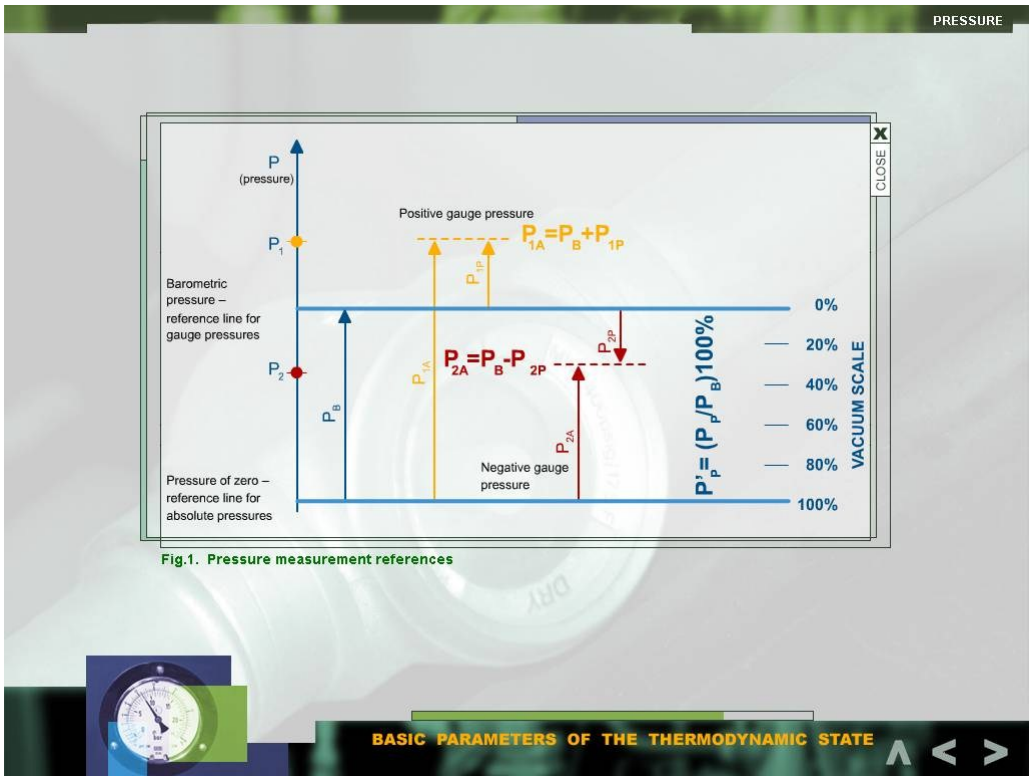
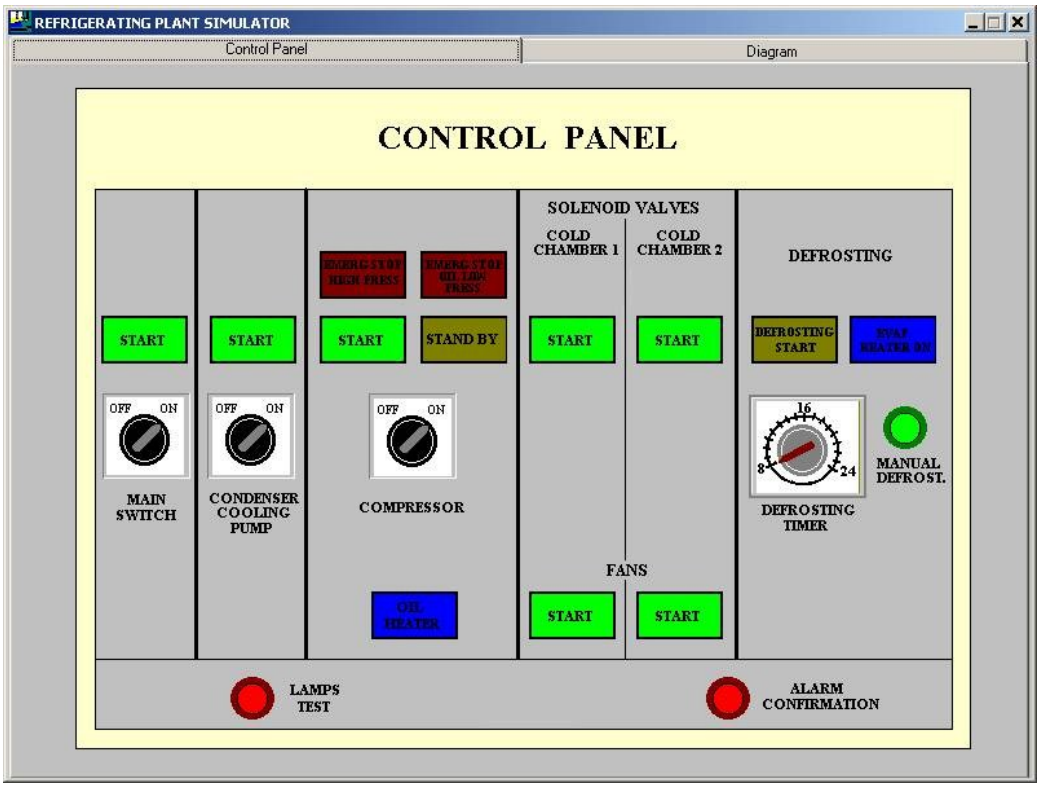
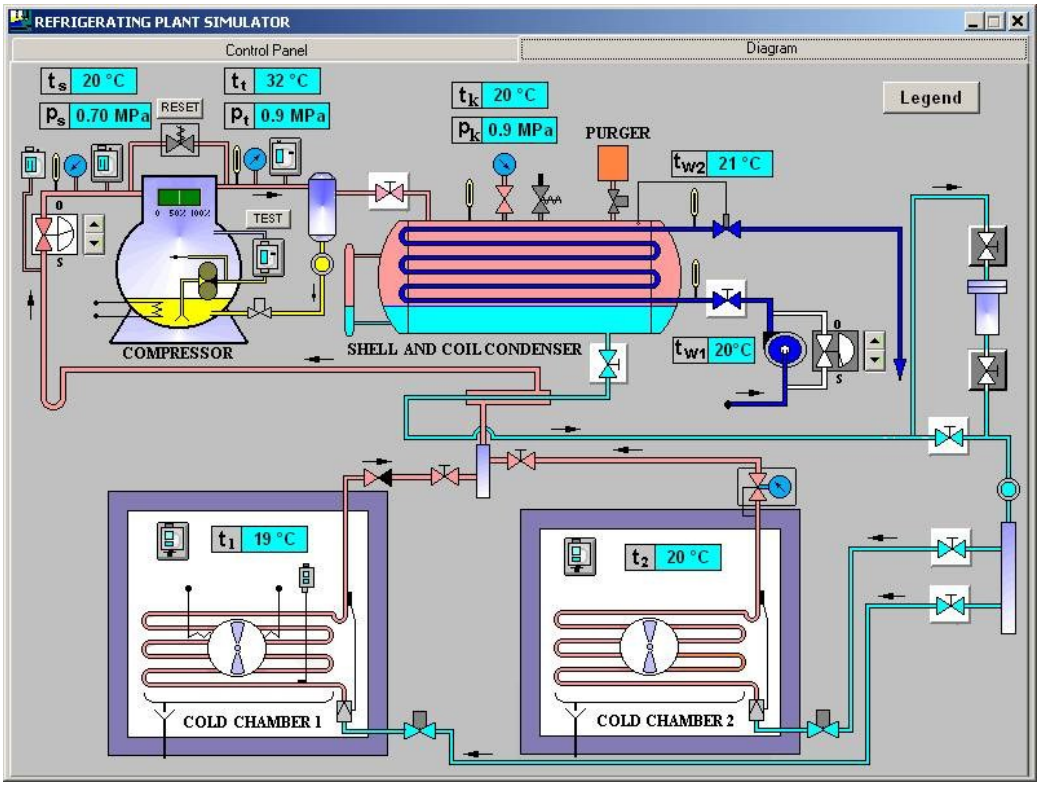


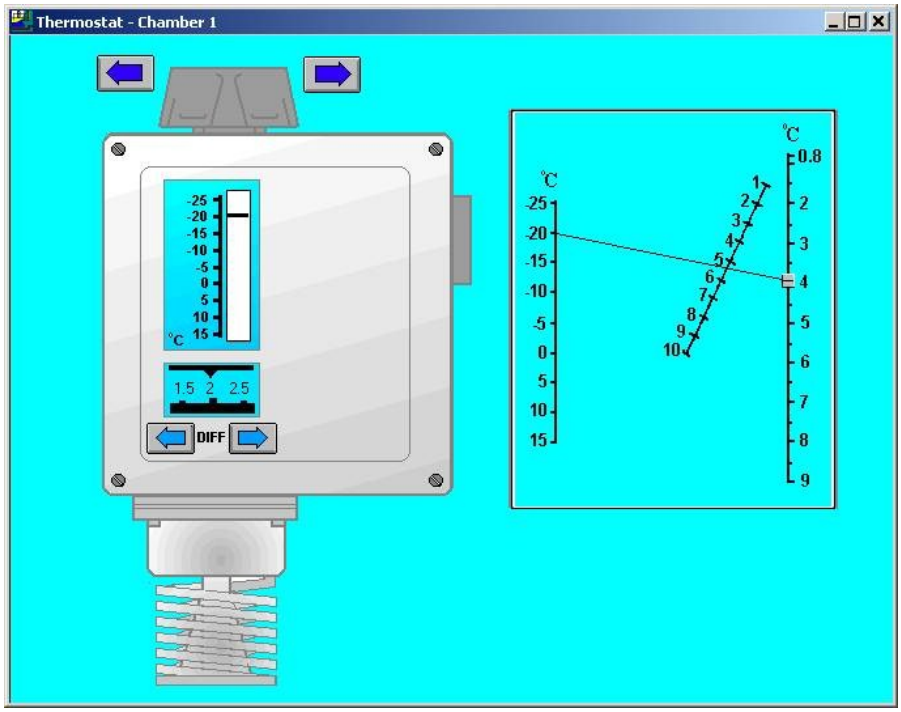

Fig.1. Pressure measurement references

The **simulator program** is interactive i.e. it enable the realistic presentation of the Refrigeration Plant functioning. System reaction are identically as it happens during normal operations. The simulator consists of the following parts:

- Control panel
- Installation Diagram
- Regulator and safety devices diagrams




REFRIGERATING PLANT SIMULATOR
Control Panel
Diagram
Legend
$t_s$ 20 °C
$p_s$ 0.70 MPa
RESET
$t_t$ 32 °C
$p_t$ 0.9 MPa
$t_k$ 20 °C
$p_k$ 0.9 MPa
PURGER
$t_{w2}$ 21 °C
TEST
COMPRESSOR
SHELL AND COIL CONDENSER
$t_{w1}$ 20°C
$t_1$ 19 °C
$t_2$ 20 °C
COLD CHAMBER 1
COLD CHAMBER 2


Thermostat - Chamber 1
°C
DIFF

# REFRIGERATING PLANT 3D

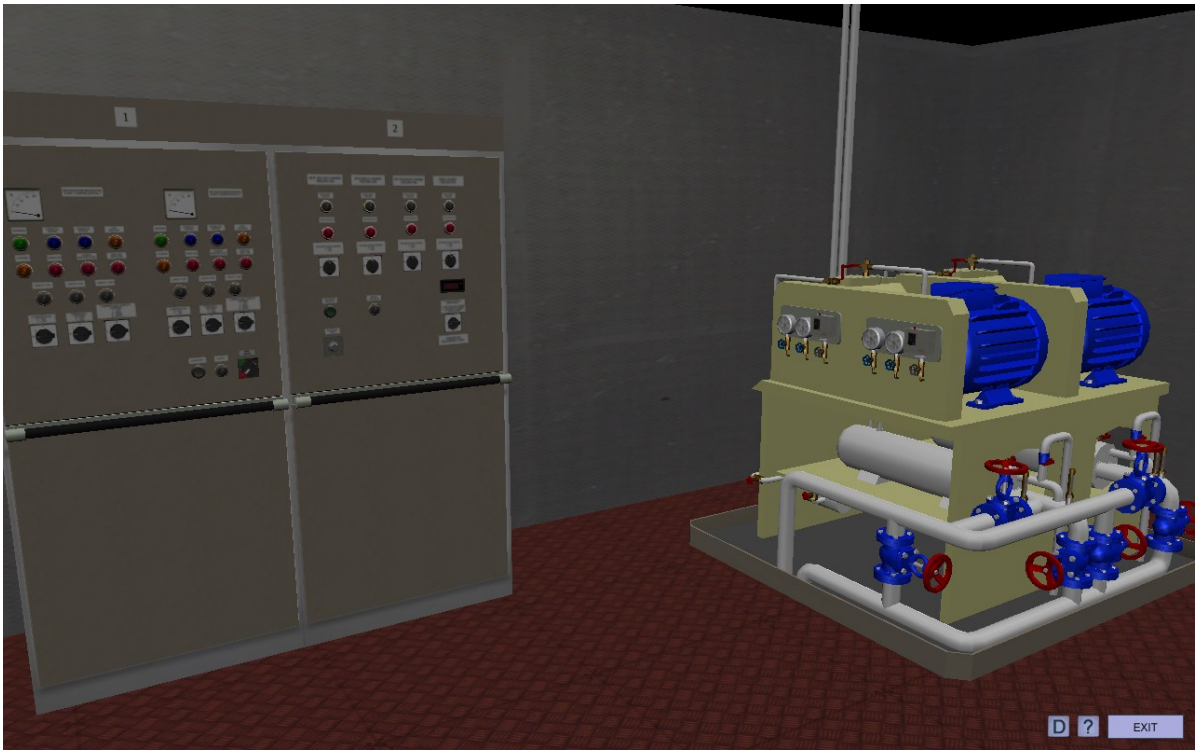
The educational program **REFRIGERATING PLANT 3D** - training simulator, is designated for learning the essential principles of the refrigeration room maintenance. The program is based on a refrigerating plant with four cold chambers:

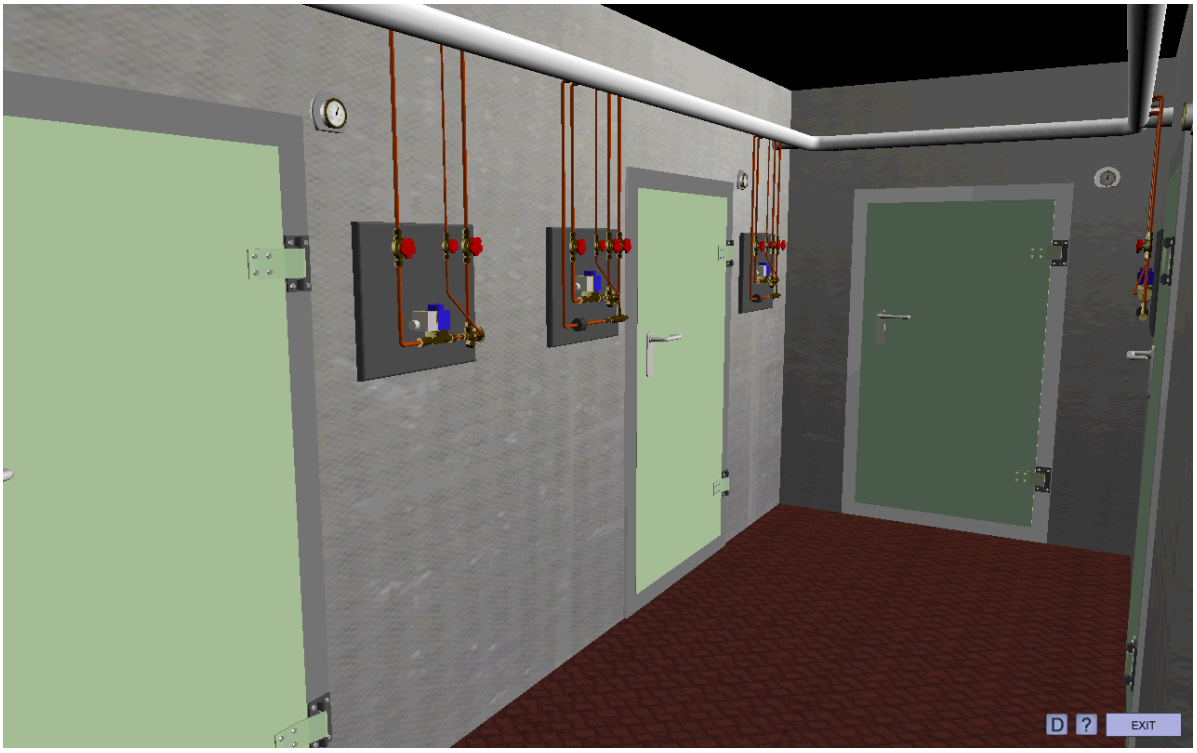
- Meat/fish cold chamber with temperature –25 °C
- Dry provision cold chamber with temperature +10 °C
- Dairy cold chamber with temperature +4 °C
- Vegetables cold chamber with temperature +4 °C

The chambers are serviced by two compressors. The refrigerant medium is freon R 404A.

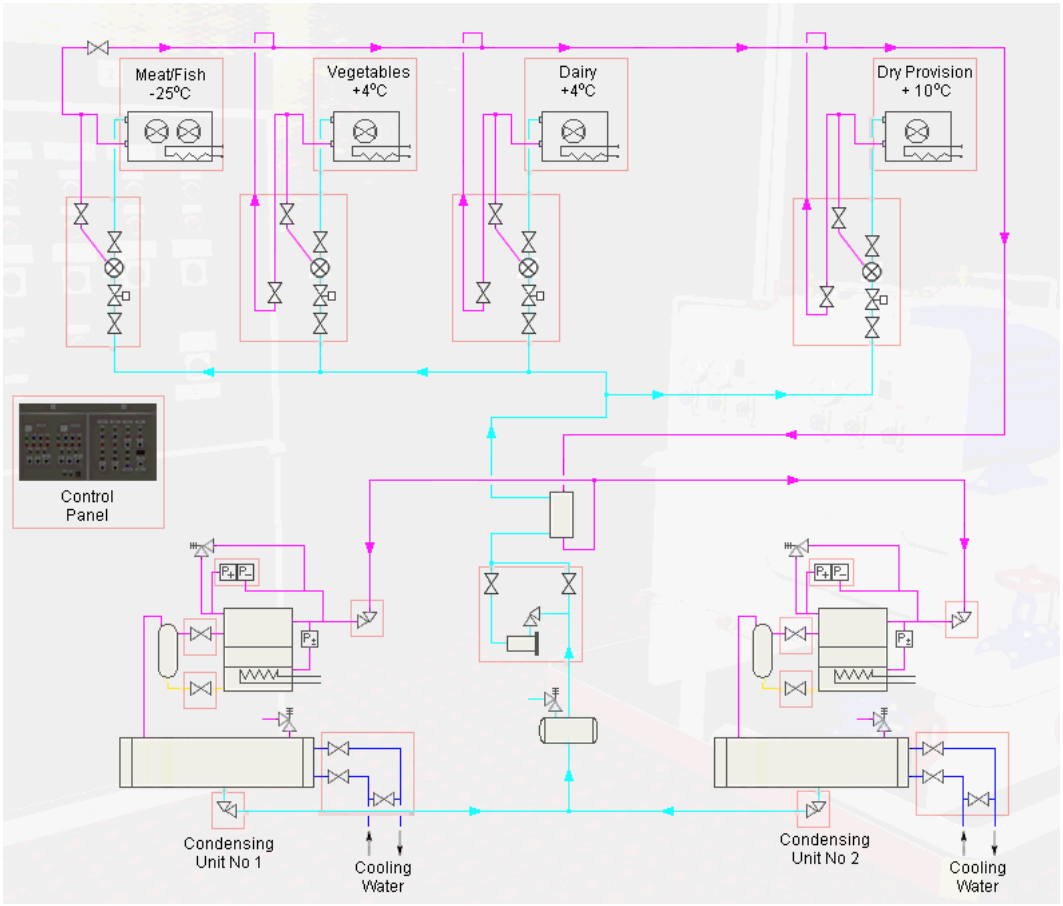
The refrigerating plant consists of the following main components:

1. Two compressors
2. Two condensers
3. Control panel
4. Four cold chambers with air coolers and valve's block






The simulator diagram shows the basic configuration of freshwater generator and status of main element and valves. Basic parameters of the system are also presented.



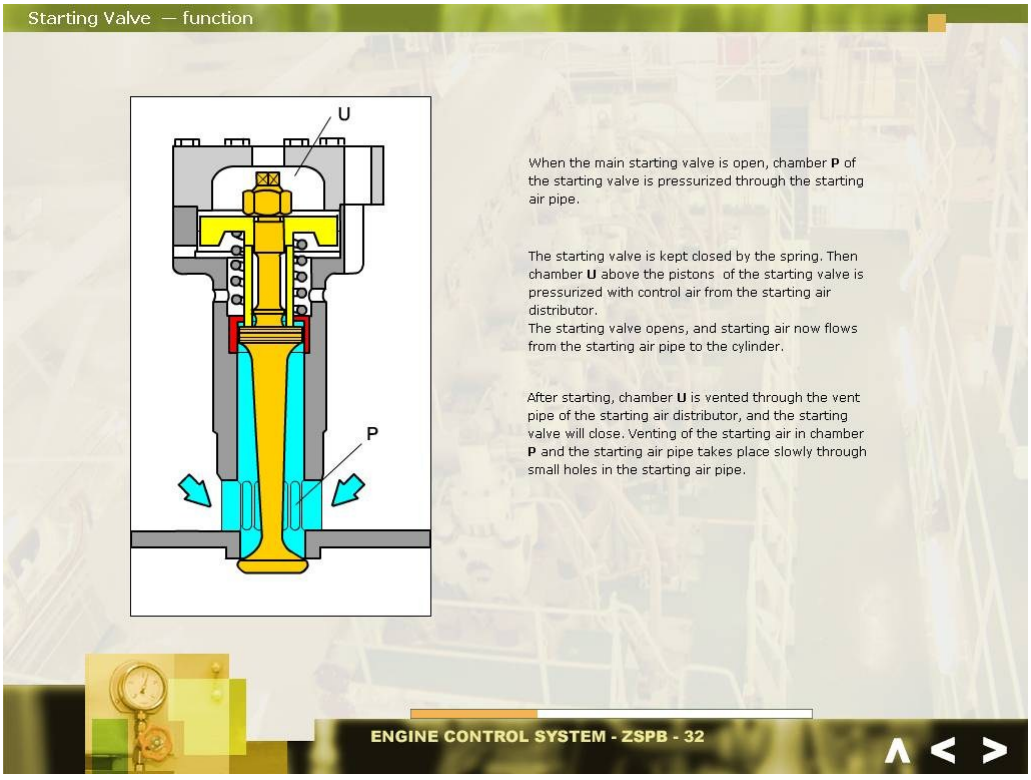
# REMOTE CONTROL SYSTEM AUTO CHIEF 4

# for MAN B&W LMC ENGINE

The educational program **REMOTE CONTROL SYSTEM AUTO CHIEF 4 for MAN B&W LMC ENGINE** is intended for teaching the basic principles of how to operate a typical automatic system, that is being presently used on ships. This simulator is based on the AUTOCHIEF-4 remoter control system, produced by NORCONTROL AUTOMATION A.S., executive operations are realized through engine control system **ZSPB-32**.

The program consists of two main parts:

- Multimedia presentation
- Simulator



The multimedia presentation part of the program consists of main sections mentioned below:

1. Description of the **Remote Control System - AUTO CHIEF 4** (introduction on the working principles and basic modules of the Remote Control System - AutoChief 4).

a) Application and sub-system of AutoChief 4
b) Remote Control System - bridge unit
c) Remote Control System - control room unit
d) Remote Control System - local control panel
e) Engine Telegraph System (ETS)
f) Safety System Unit (SSU)
g) Order Printer Unit (OPU)

2. Description of the Engine Control System - ZSPB 32 (introduction on the working principles and basic element of the system)

a) engine control diagram
b) function of control
c) main elements description - working principles, animation and pictures:

- Main starting valve
- Starting valve
- Starting air distributor
- Fuel valve

3. Normal operating procedures
4. Emergency Operating procedures
5. Assessment - some questions about the theory and the practice in the skill test

## Main Starting Valve

By activating the main starting valve the compressed air is released to engine's cylinder via the starting valves. This causes the engine crankshaft to turn.

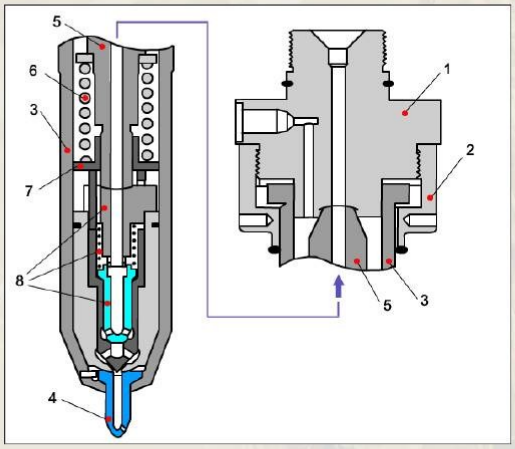
In all other operating positions the main starting valve remains closed and thus prevents an undesired, dangerous, blow-in of starting air into the cylinders.

The main starting valve consists of a large ball valve and a smaller ball valve. The smaller valve is fitted as a by pass for the large valve. Both valves are operated by means of pneumatic actuators.

Furthermore, a non-return valve is incorporated which prevents blow-back in the event of excessive pressure in the starting air line.

The two ball valves and their actuators are, together with the non-return valve, built together to form a unit.

## Fuel Valve

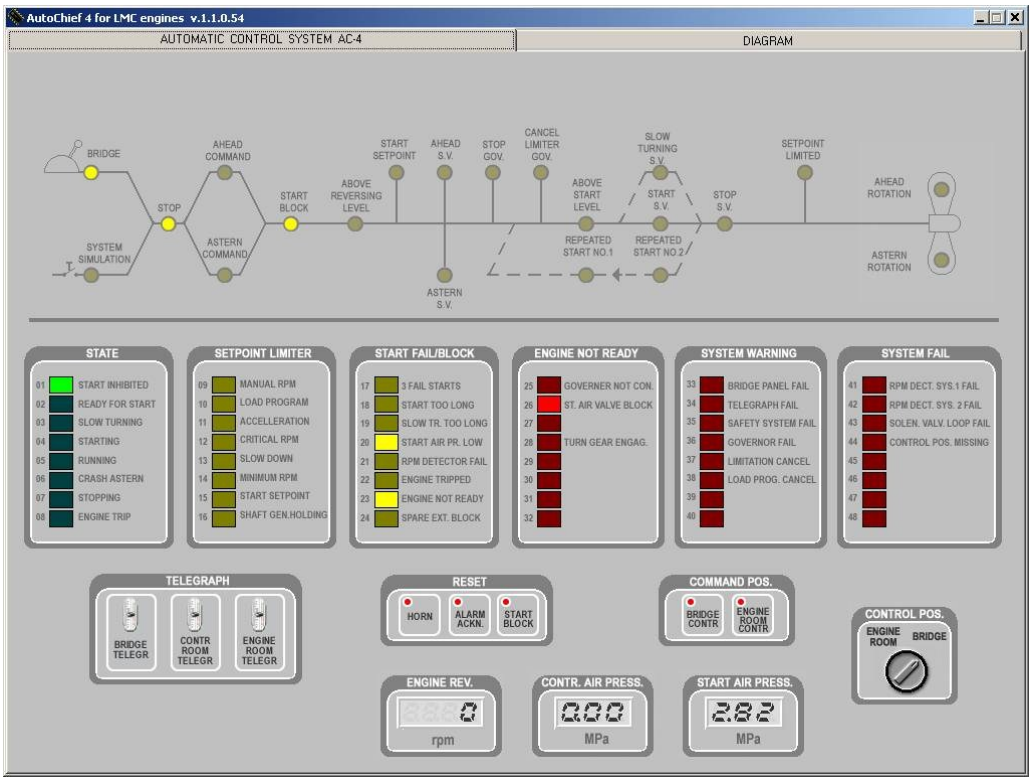


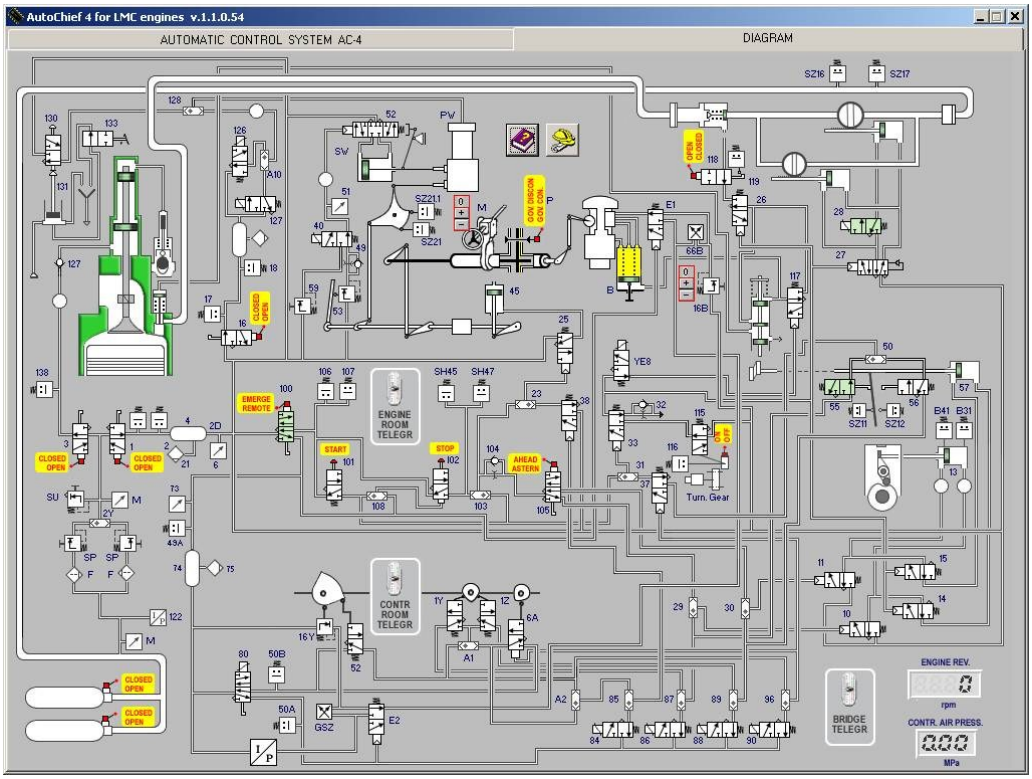

The fuel valve consists of a valve head **1**, union nut **2**, valve body **3**, and nozzle **4**. Fitted within the valve body are the thrust spindle **5** with thrust spring **6**, thrust foot **7**, and valve unit **8** with a combined slide/valve.

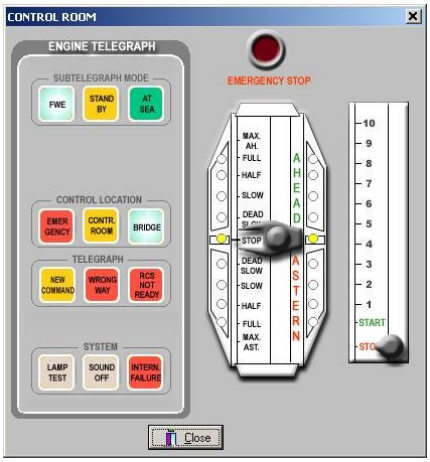
When the fuel valve is fitted in the cylinder cover, the valve parts are tightened together by the pressure from the nuts.

**The simulator program** is interactive i.e. it enable the realistic presentation of the Remote Control System functioning. System reaction are identically as it happens during normal operations. The simulator consists of the following parts:

- Engine Telegraph and Bridge Subtelegraph
- Engine Telegraph and Control Room Subtelegraph
- Engine Telegraph and Emergency Subtelegraph
- Control Room Unit Panel
- Engine Control System Diagram




AutoChief 4 for LMC engines v.1.1.0.54
AUTOMATIC CONTROL SYSTEM AC-4
DIAGRAM
ENGINE ROOM TELEGR
CONTR ROOM TELEGR
EMERGE REMOTE
START
STOP
AHEAD ASTERN
Turn. Gear
BRIDGE TELEGR
ENGINE REV.
CONTR. AIR PRESS.
CLOSED OPEN


CONTROL ROOM
ENGINE TELEGRAPH
SUBTELEGRAPH MODE
FWE
STAND BY
AT SEA
CONTROL LOCATION
EMER GENCY
CONTR. ROOM
BRIDGE
TELEGRAPH
NEW COMMAND
WRONG WAY
RCS NOT READY
SYSTEM
LAMP TEST
SOUND OFF
INTERN. FAILURE
EMERGENCY STOP
MAX. AH.
FULL
HALF
SLOW
DEAD SLOW
STOP
DEAD SLOW
SLOW
HALF
FULL
MAX. AST.
AHEAD
ASTERN
START
Close

# REMOTE CONTROL SYSTEM AUTO CHIEF 4 for SULZER RTA ENGINE

The educational program **REMOTE CONTROL SYSTEM AUTO CHIEF 4 for SULZER RTA ENGINE** is intended for teaching the basic principles of how to operate a typical automatic system, that is being presently used on ships. This simulator is based on the AUTOCHIEF-4 remote control system, produced by NORCONTROL AUTOMATION A.S., executive operations are realized through engine control system (diesel engine interface) **DENIS -1**.

The program consists of two main parts:

- Multimedia presentation
- Simulator

The multimedia presentation part of the program consists of main sections mentioned below:

1. Description of the **Remote Control System - AUTO CHIEF 4** (introduction on the working principles and basic modules of the Remote Control System - AutoChief 4).

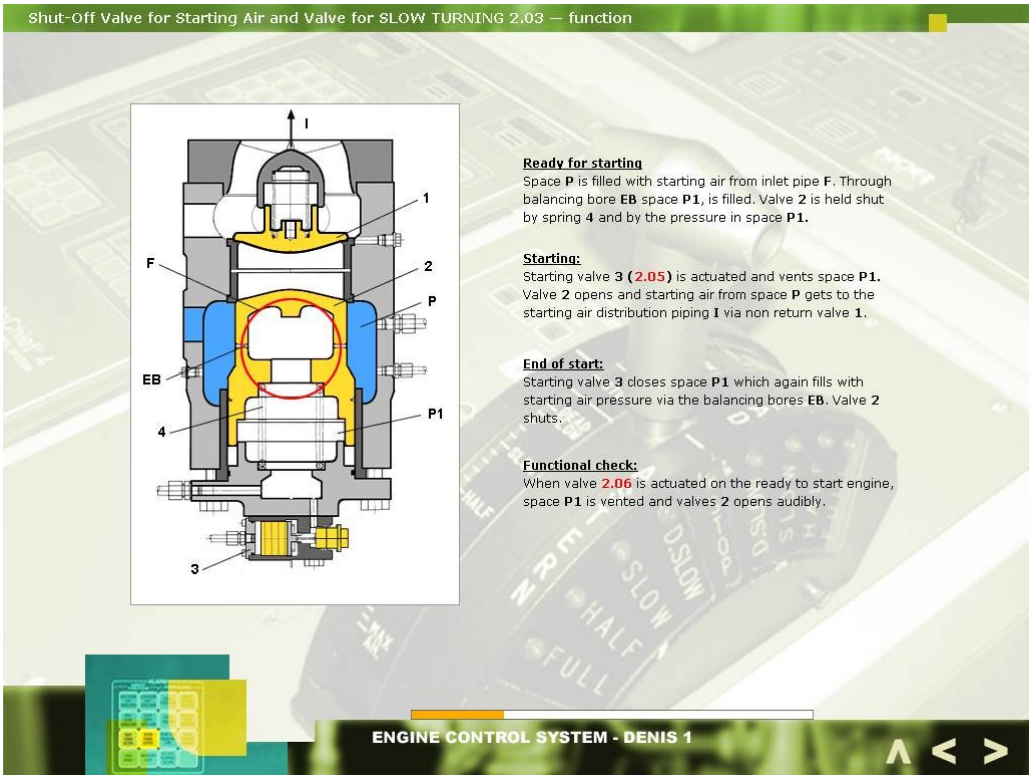
a) Application and sub-system of AutoChief 4
b) Remote Control System - bridge unit
c) Remote Control System - control room unit
d) Remote Control System - local control panel
e) Engine Telegraph System (ETS)
f) Safety System Unit (SSU)
g) Order Printer Unit (OPU)

2. Description of the Engine Control System - DENIS 1 (introduction on the working principles and basic element of the Engine Control System - Denis 1)

a) engine control diagram
b) function of control
c) main elements description - working principles, animation and pictures:

- Shut-Off Valve for Starting Air and Valve for SLOW TURNING
- Starting valve
- Starting air distributor
- Reversing valve
- Safety cut-out device
- Directional Control Valve

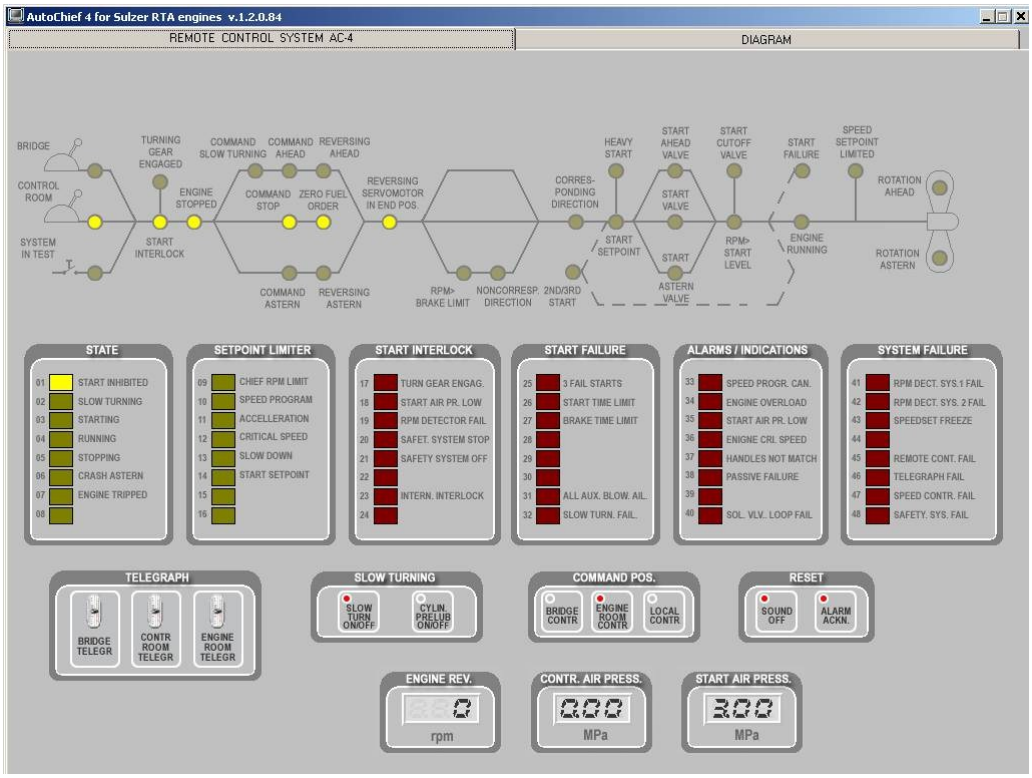
3. Normal operating procedures
4. Emergency Operating procedures
5. Assessment - some questions about the theory and the practice in the skill test


Shut-Off Valve for Starting Air and Valve for SLOW TURNING 2.03 – function
I
1
F
2
P
EB
P1
4
3
Ready for starting
Space P is filled with starting air from inlet pipe F. Through balancing bore EB space P1, is filled. Valve 2 is held shut by spring 4 and by the pressure in space P1.
Starting:
Starting valve 3 (2.05) is actuated and vents space P1. Valve 2 opens and starting air from space P gets to the starting air distribution piping I via non return valve 1.
End of start:
Starting valve 3 closes space P1 which again fills with starting air pressure via the balancing bores EB. Valve 2 shuts.
Functional check:
When valve 2.06 is actuated on the ready to start engine, space P1 is vented and valves 2 opens audibly.
ENGINE CONTROL SYSTEM - DENIS 1

Engine Telegraph System
The Norcontrol Automation Engine Telegraph System (ETS) constitute a very important link between the bridge, control room and local engine control for transfer of messages, such as:
Finished with engine
Stand by
At sea
Wrong way alarm
Power failure alarm
Remote control system status
Interface to Order Printer
Engine control location
REMOTE CONTROL SYSTEM - AUTOCHIEF 4

The **simulator program** is interactive i.e. it enable the realistic presentation of the Remote Control System functioning. System reaction are identically as it happens during normal operations The simulator consists of the following parts:

- Engine Telegraph and Bridge Subtelegraph
- Engine Telegraph and Control Room Subtelegraph
- Engine Telegraph and Emergency Subtelegraph
- Control Room Panel
- Engine Control System Diagram
- Air Station Diagram

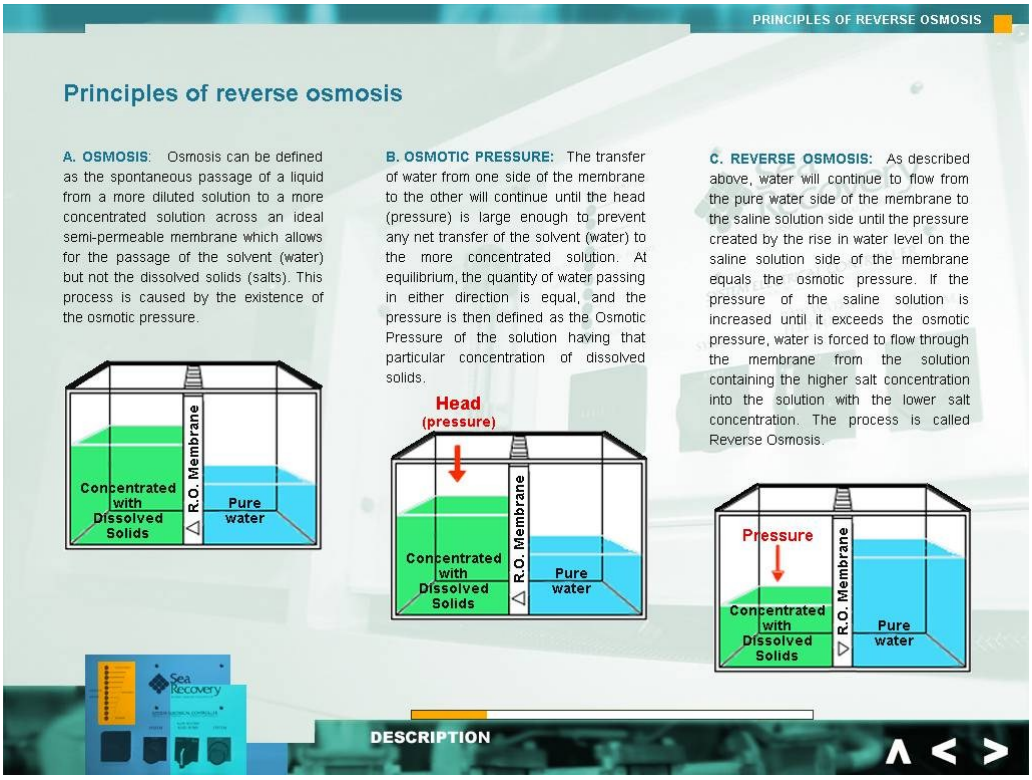


# REVERSE OSMOSIS DESALINATION SYSTEM

The educational program **REVERSE OSMOSIS DESALINATION SYSTEM** is intended for teaching the basic principles of how to operate a typical Reverse Osmosis Desalination System.
The program is based on an installation SRC 15m3 SW/S1 produced by SEA RECOVERY corporation (U.S.A.).

The program consists of two main parts:

- Multimedia presentation
- Simulator



The multimedia presentation part of the program consists of main sections mentioned below:

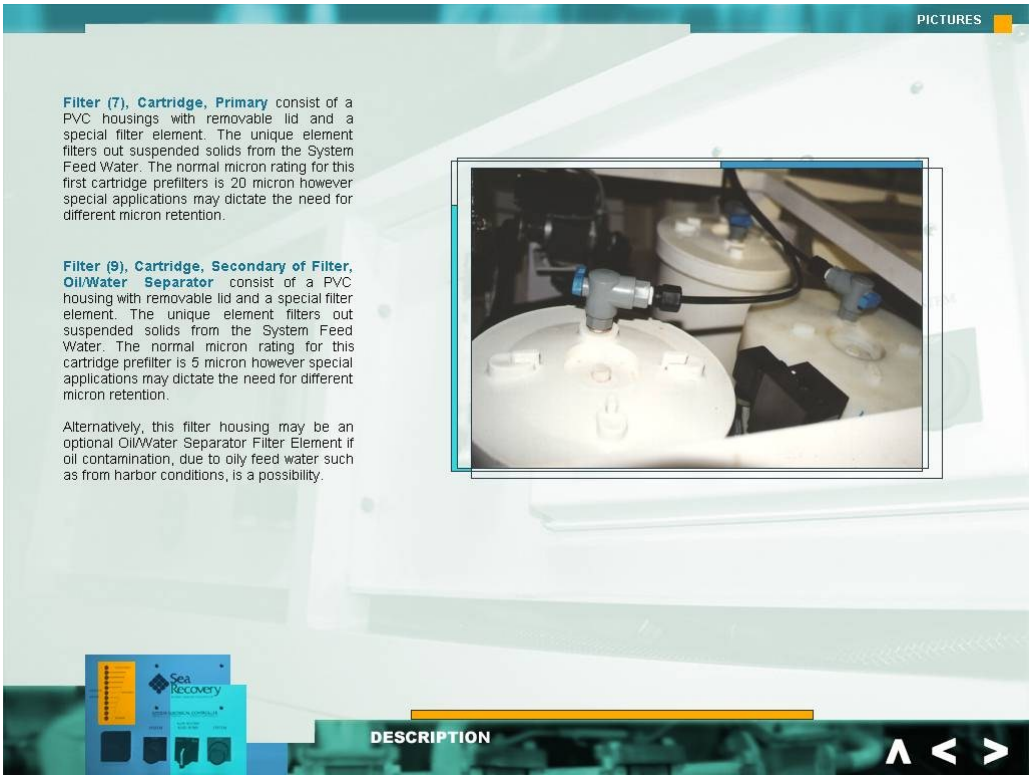
1. Description (introduction on the working principles and basic modules of the typical Reverse Osmosis Desalination System)

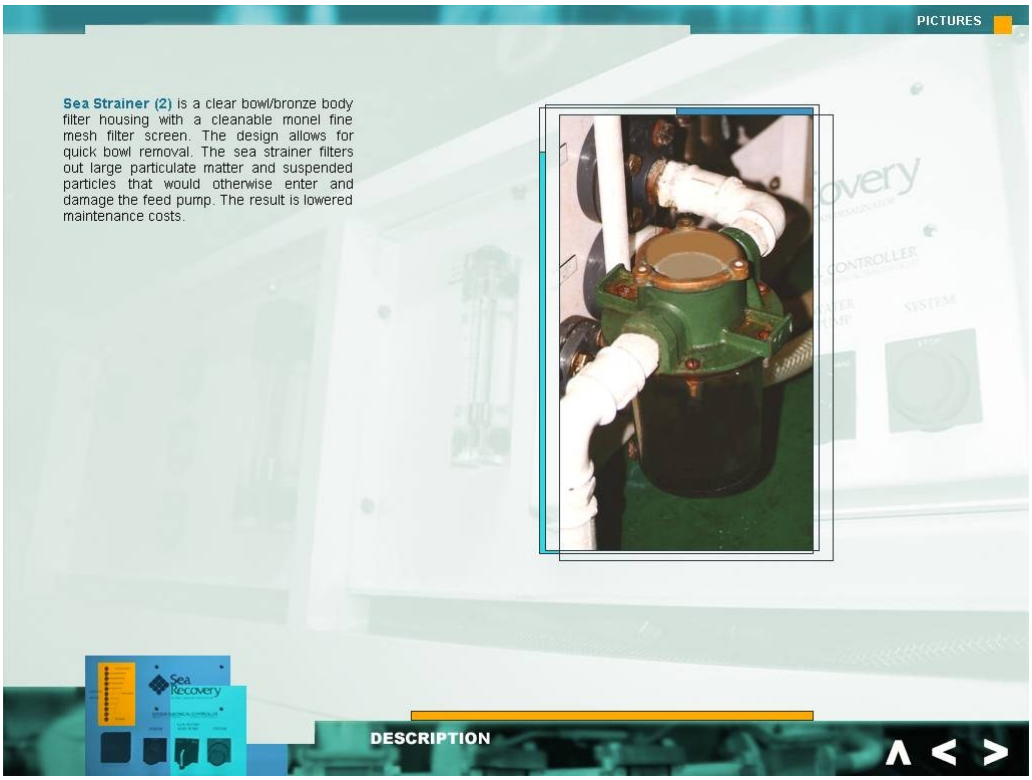
   a) System introduction
   b) Principles of reverse osmosis
   c) How it works
   d) Pictures

2. Operating

   a) Start up procedure
   b) Shut down procedure
   c) Storage & Cleaning procedure
   d) Filters Cleaning procedure

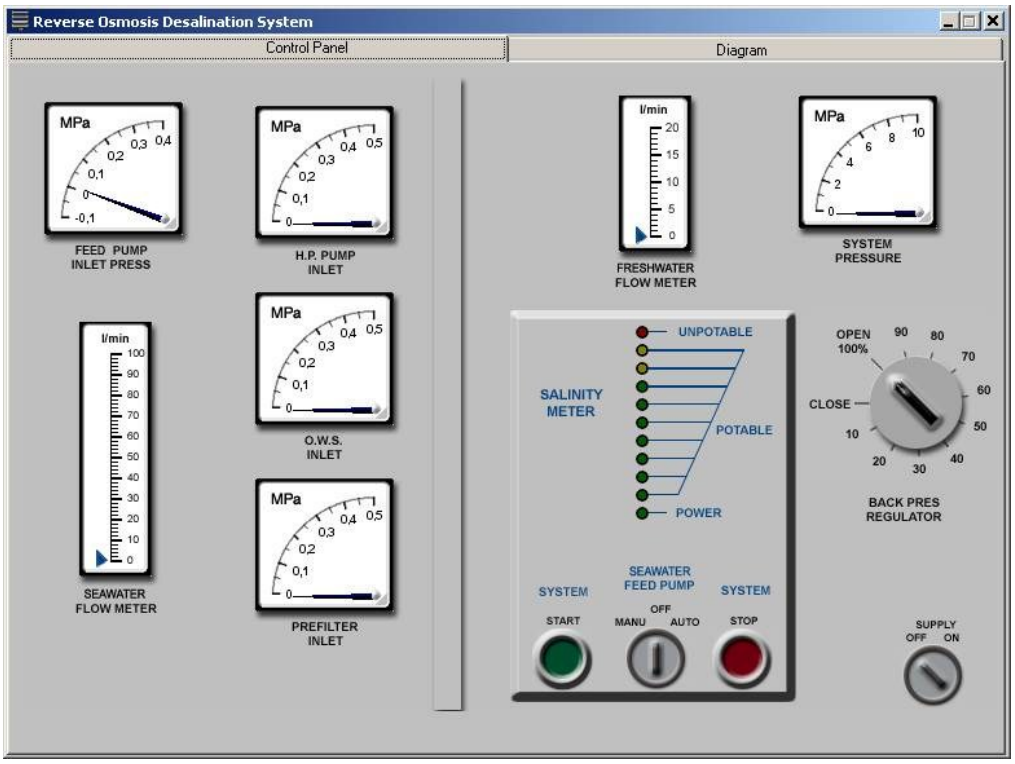
3. Assessment - some questions about the theory and the practice in the skill test

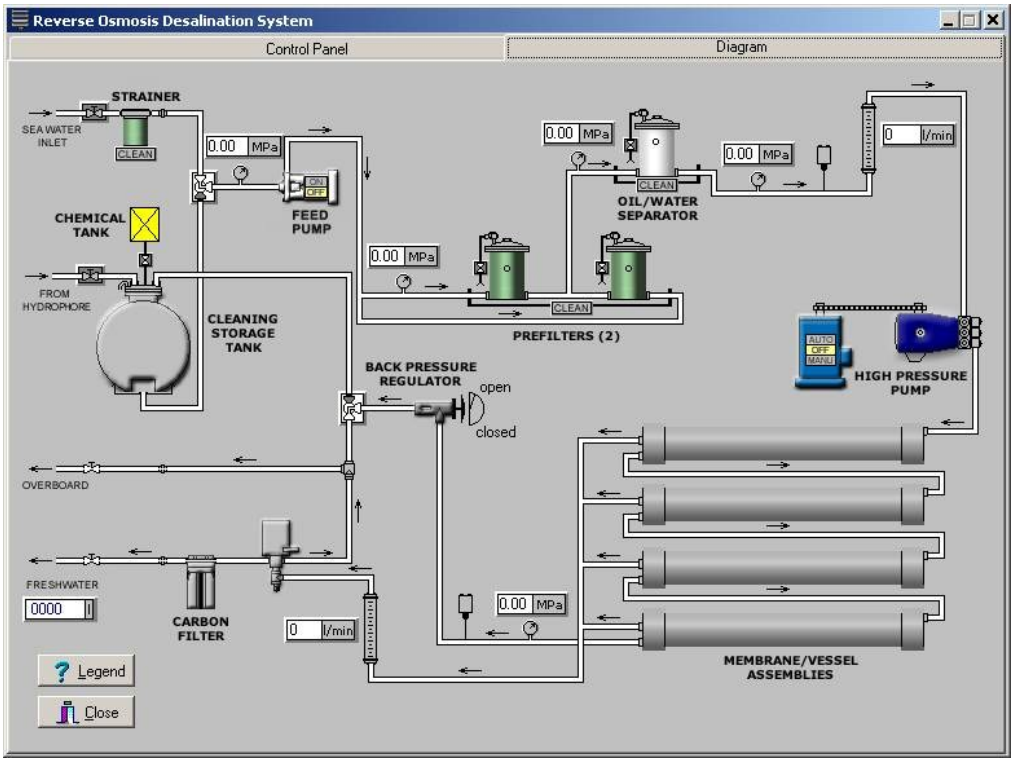

PICTURES
Filter (7), Cartridge, Primary consist of a PVC housings with removable lid and a special filter element. The unique element filters out suspended solids from the System Feed Water. The normal micron rating for this first cartridge prefilters is 20 micron however special applications may dictate the need for different micron retention.
Filter (9), Cartridge, Secondary of Filter, Oil/Water Separator consist of a PVC housing with removable lid and a special filter element. The unique element filters out suspended solids from the System Feed Water. The normal micron rating for this cartridge prefilter is 5 micron however special applications may dictate the need for different micron retention.
Alternatively, this filter housing may be an optional Oil/Water Separator Filter Element if oil contamination, due to oily feed water such as from harbor conditions, is a possibility.
Sea Recovery
DESCRIPTION


PICTURES
Sea Strainer (2) is a clear bowl/bronze body filter housing with a cleanable monel fine mesh filter screen. The design allows for quick bowl removal. The sea strainer filters out large particulate matter and suspended particles that would otherwise enter and damage the feed pump. The result is lowered maintenance costs.
Sea Recovery
DESCRIPTION

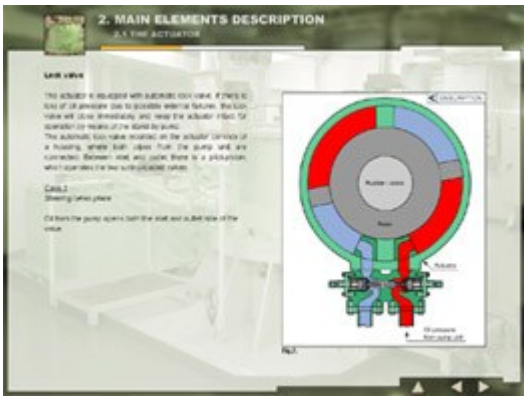
**The simulator** program is interactive i.e. it enable the realistic presentation of the Remote Control System functioning. System reaction are identically as it happens during normal operations The simulator consists of the following parts:

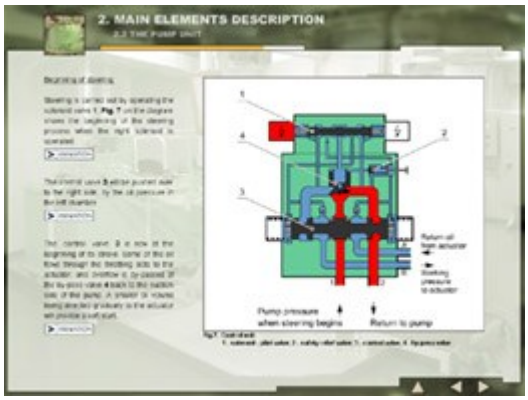
- Control Panel
- Diagram



# ROTARY VANE STEERING GEAR




The educational program **ROTARY VANE STEERING GEAR** is intended for teaching the basic principles of how to operate typical electro-hydraulic rotary vane steering gear.

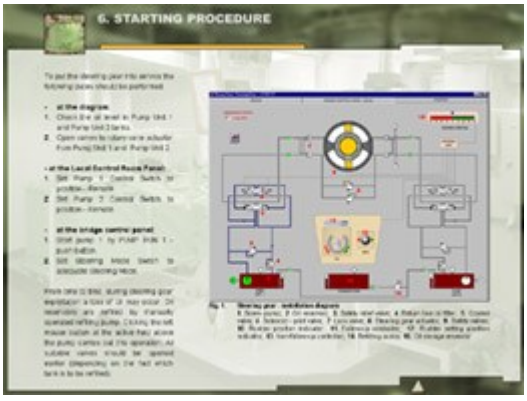
The steering gear is composed of one hydraulic rotary vane actuator mounted directly on the rudder stock, served by two pump units delivering the necessary oil pressure for operating the rudder.

The program consists of two main parts:

- Multimedia presentation
- Simulator

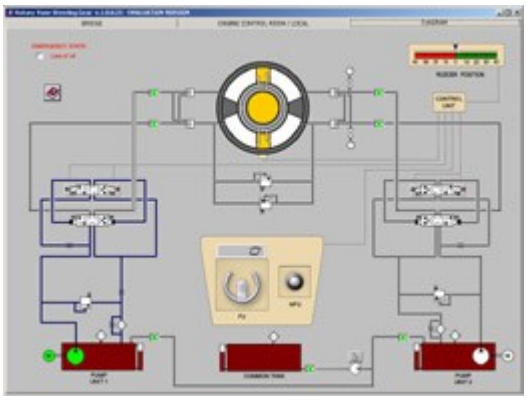
The **multimedia presentation** part of the program consists of main sections mentioned below:

1. General description of the Rotary Vane Steering Gear and technical data.
2. Main elements description.
3. System elements' photos.
4. Steering gear operating mode.
5. Starting procedure.
6. Assessment - some questions about the theory and the practice in the skill test.



The **Rotary Vane Steering Gear Simulator** consists of the following parts:

- Bridge Control Panel
- Control Room / Local Control Panel
- Diagram

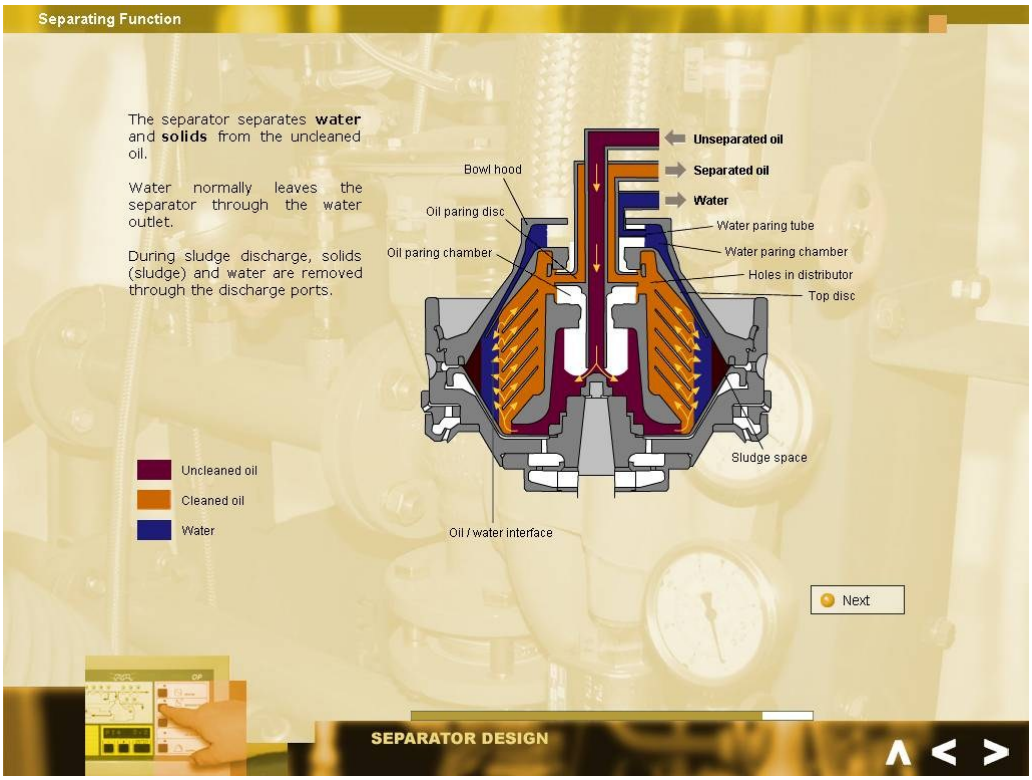


# S-TYPE SEPARATION SYSTEM

The educational program **S-TYPE SEPARATION SYSTEM** is intended for teaching the basic principles of cleaning fuel and lube oils diesel engines, and fuel oil for gas turbine engines, in marine and power applications. This simulator is based on the S-type Separation System, produced by ALFA LAVAL.

The program consists of two main parts:

- Multimedia presentation
- Simulator



The multimedia presentation part of the program consists of main sections mentioned below:

1. Description of the **S-type Separation System** (introduction on the working principles and basic modules).

   a) System Overview
   b) Oil flow
   c) System Layout
   d) Separation Unit Layout
   e) Separation Unit Options
   f) Modules
   g) Process Principle
   h) Process Cycle Start
   i) Discharge
   j) Increased Water Content

2. S-type Separation System Design.

   a) Main Components
   b) The Drive Section
   c) The Process Section
   e) Sensors
   f) Separating Function
   g) Discharge of water through water outlet

3. Operating instruction.

4. Parameter list - introduction on the parameters and parameter lists accessing.

5. Alarms - introduction on the alarms and fault finding.

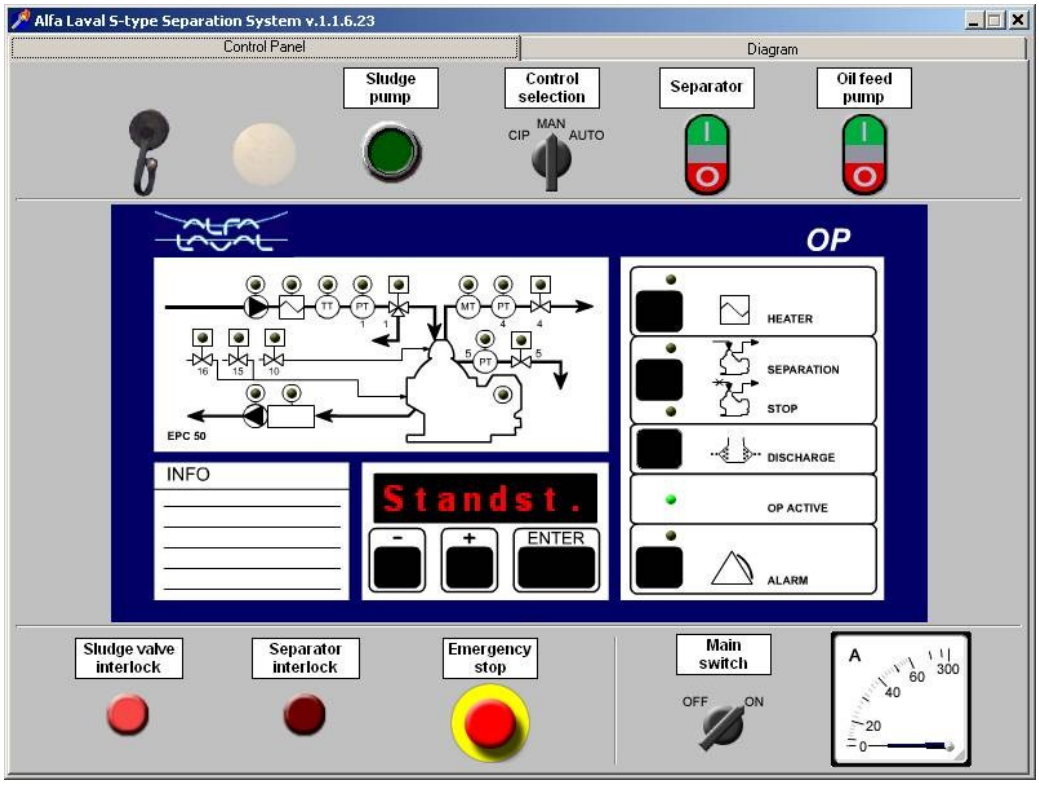
6. Assessment - some questions about the theory and the practice in the skill test.

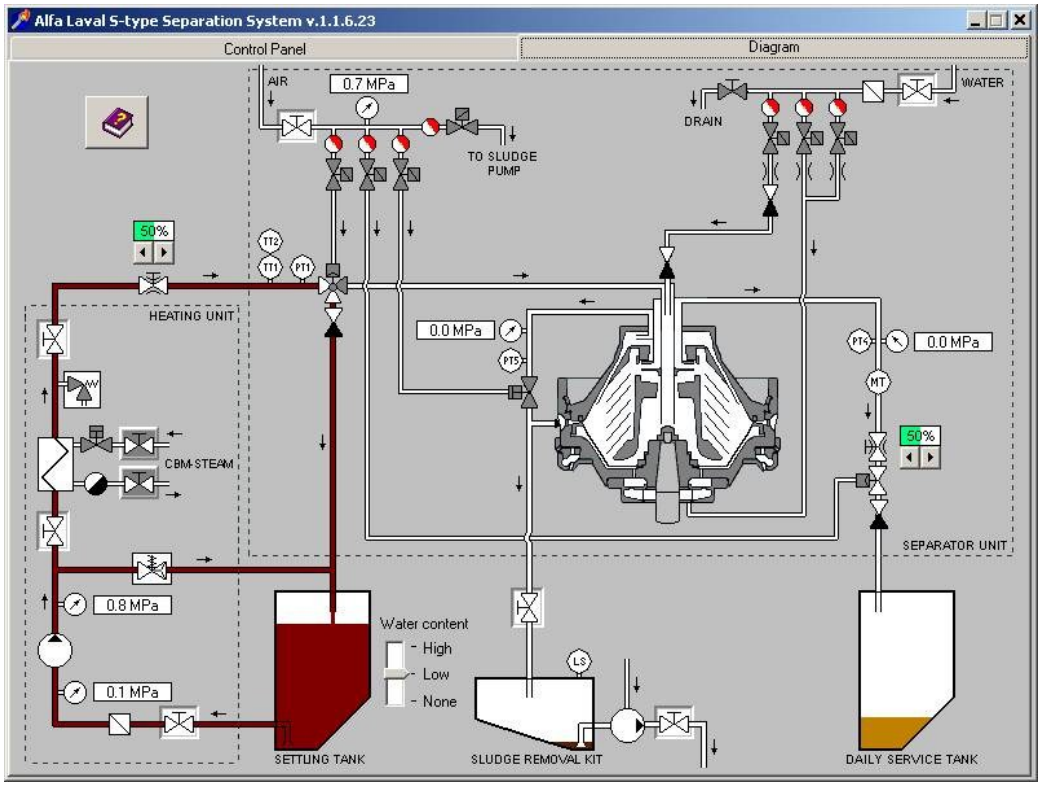
Before Startup
Check that the separator is correctly assembled and connected to power supply of correct voltage and frequency. The ECP 50 Control Unit must be ON.
WARNING
Breakdown
Assemble the separator completely before start. All couplings, covers, and guards must be in place and properly tightened. Non compliance may lead to breakdown.
Electrical hazard
Follow local regulations for electrical installation and earthing (grounding).
Breakdown hazard
Check that the power frequency is in agreement with the machine plate. If incorrect, resulting overspeed may cause breakdown.
Use the separation system for the purpose, and within the limits, specified by Alfa Laval. Failure to do so could cause a violent breakdown.
50 Hz?
60 Hz?
Next
OPERATING PROCEDURES

Emergency Stop
If an emergency situation occurs, press the emergency stop button and evacuate the room. Do not return until the separator has come to a complete standstill.
WARNING
Disintegration hazard
If unusually strong vibration occurs, press the Emergency Stop button and leave the room.
Do not enter the room after an emergency stop while the separator is still rotating.
NOTE
In order to be able to restart, the system must be at standstill, and then the ECP power switched off–on.
OPERATING PROCEDURES

The **simulator program** is interactive i.e. it enable the realistic presentation of the S-type Separation System functioning. System reaction are identically as it happens during normal operations The simulator consists of the following parts:

- Control Panel
- System Diagram



# VARIABLE DELIVERY PUMP STEERING GEAR INSTALLATION

The educational program **VARIABLE DELIVERY PUMP STEERING GEAR INSTALLATION** is intended for teaching the fundamental principles of how to operate this kind of steering gear.

The program consists of two main parts:

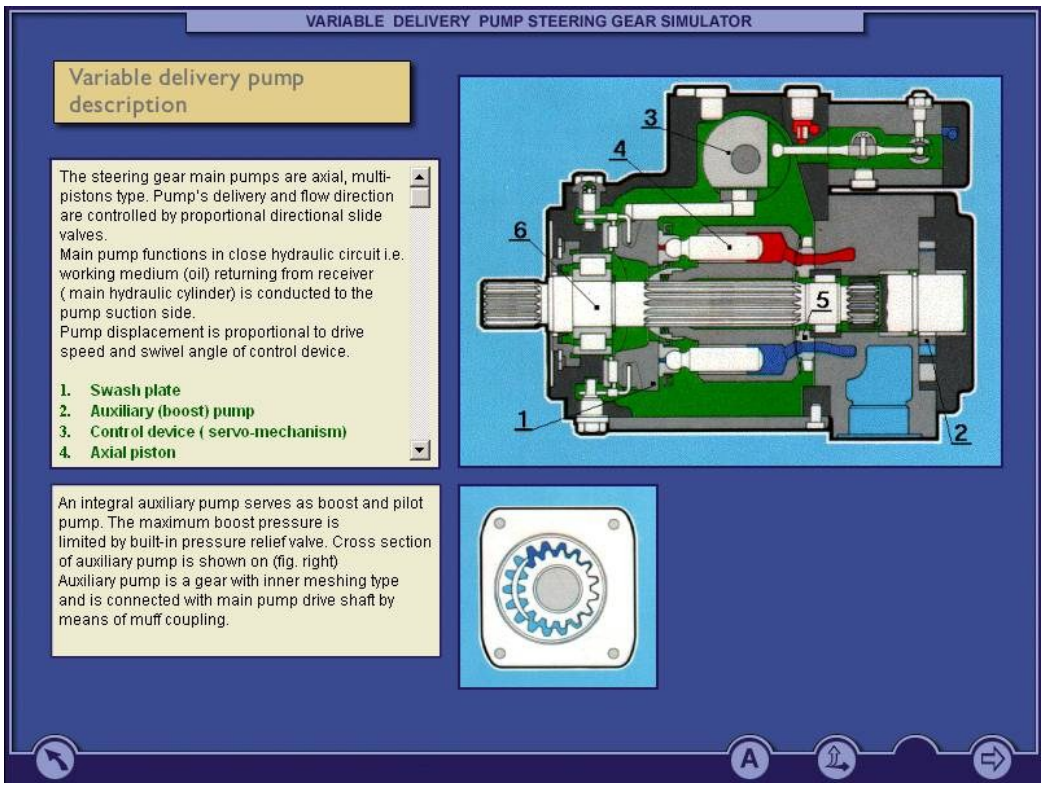
- Multimedia presentation
- Simulator

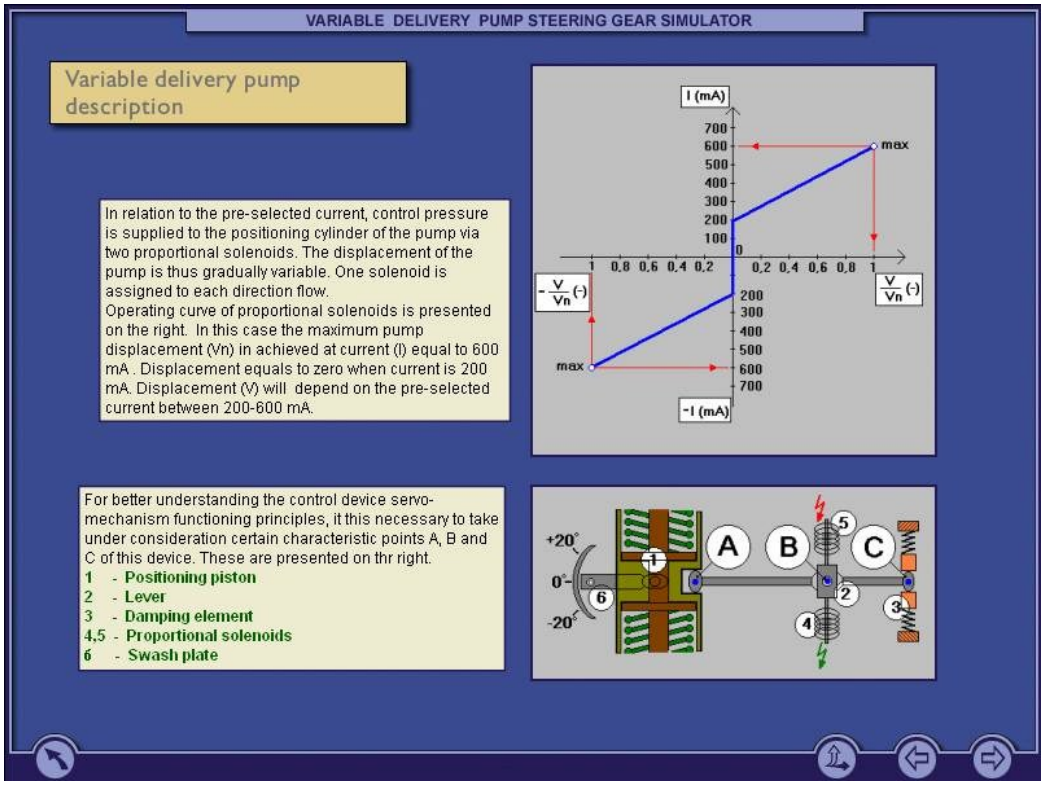
The **multimedia presentation** part of the program consists of main sections mentioned below:

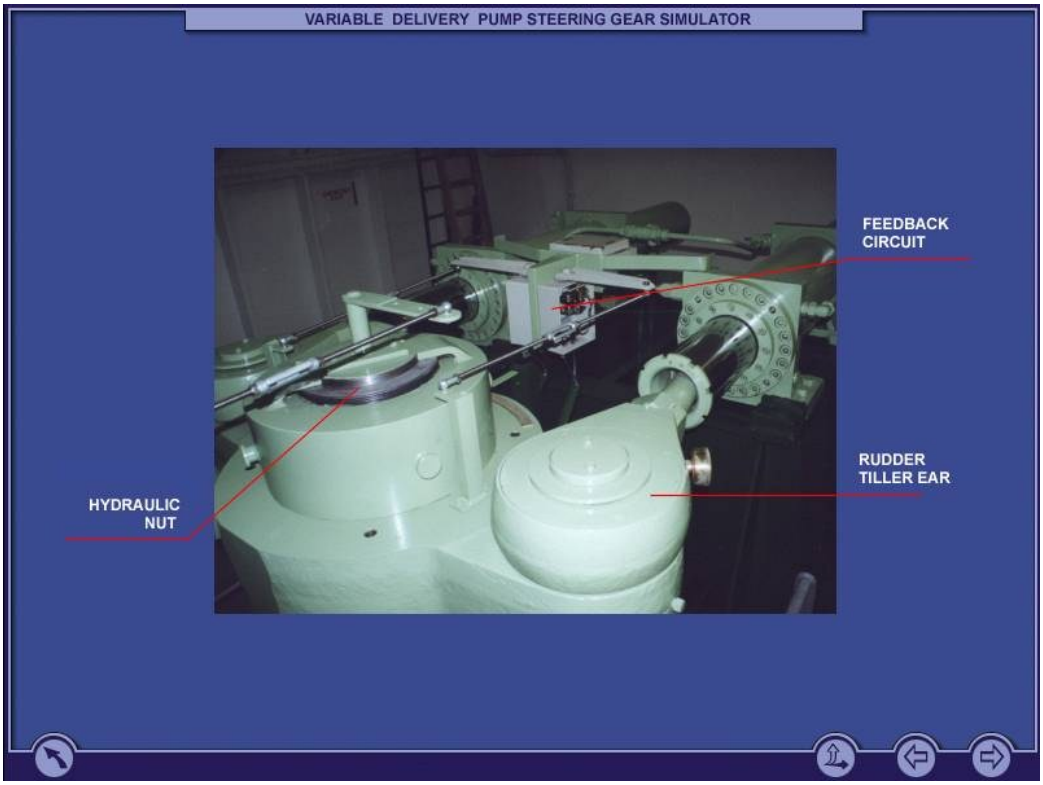
1) Description
   a) steering gear and installation
   b) variable delivery pump
   c) power switchboard panel
   d) bridge control panel
   e) engine control room panel
   f) steering gear elements pictures

2) Operating
   a) operating mode
   b) steering gear controlling
   c) starting procedure
   d) stopping procedure

3) Test

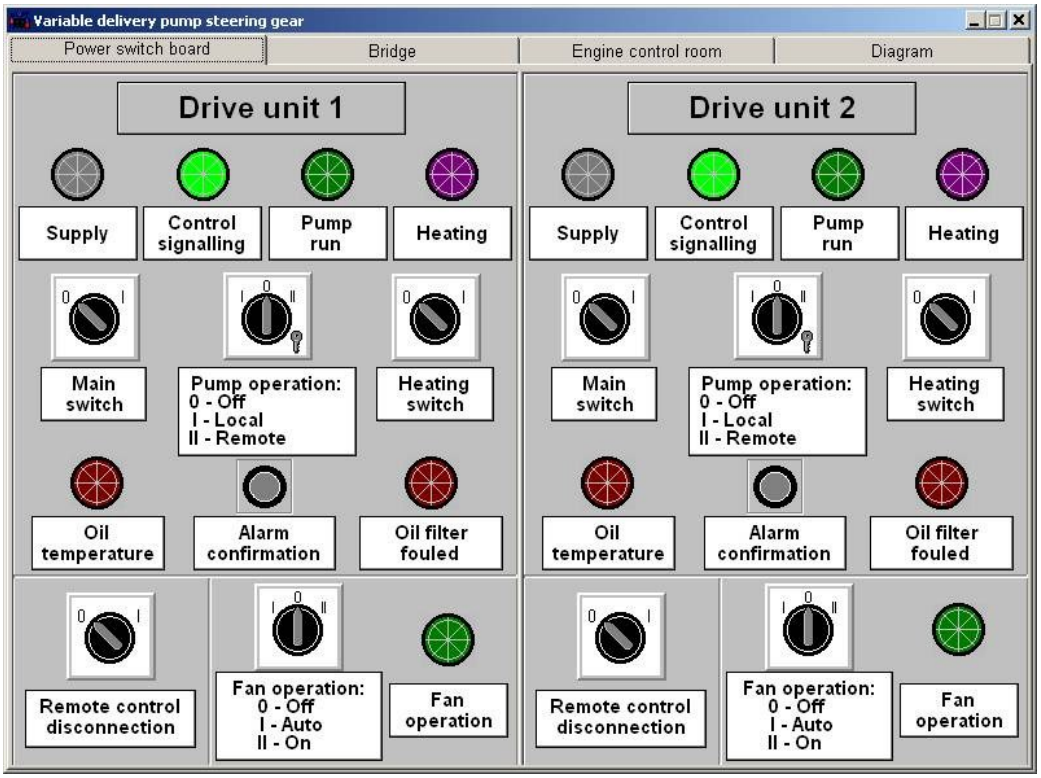


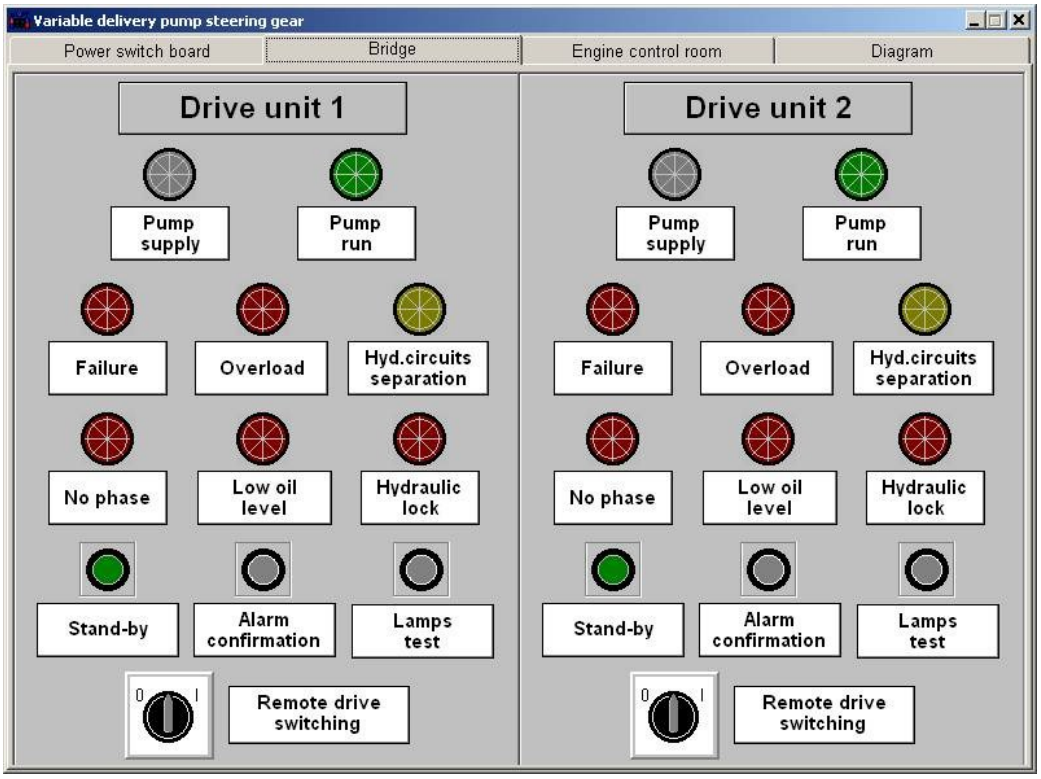

VARIABLE DELIVERY PUMP STEERING GEAR SIMULATOR
Variable delivery pump description
In relation to the pre-selected current, control pressure is supplied to the positioning cylinder of the pump via two proportional solenoids. The displacement of the pump is thus gradually variable. One solenoid is assigned to each direction flow.
Operating curve of proportional solenoids is presented on the right. In this case the maximum pump displacement (Vn) in achieved at current (I) equal to 600 mA . Displacement equals to zero when current is 200 mA. Displacement (V) will depend on the pre-selected current between 200-600 mA.
I (mA)
700
600
500
400
300
200
100
0
max
1 0.8 0.6 0.4 0.2
0.2 0.4 0.6 0.8 1
- V/Vn (-)
V/Vn (-)
200
300
400
500
600
700
max
-I (mA)
For better understanding the control device servo-mechanism functioning principles, it this necessary to take under consideration certain characteristic points A, B and C of this device. These are presented on thr right.
1 - Positioning piston
2 - Lever
3 - Damping element
4,5 - Proportional solenoids
6 - Swash plate
+20°
0°
-20°
A
B
C
1
2
3
4
5
6

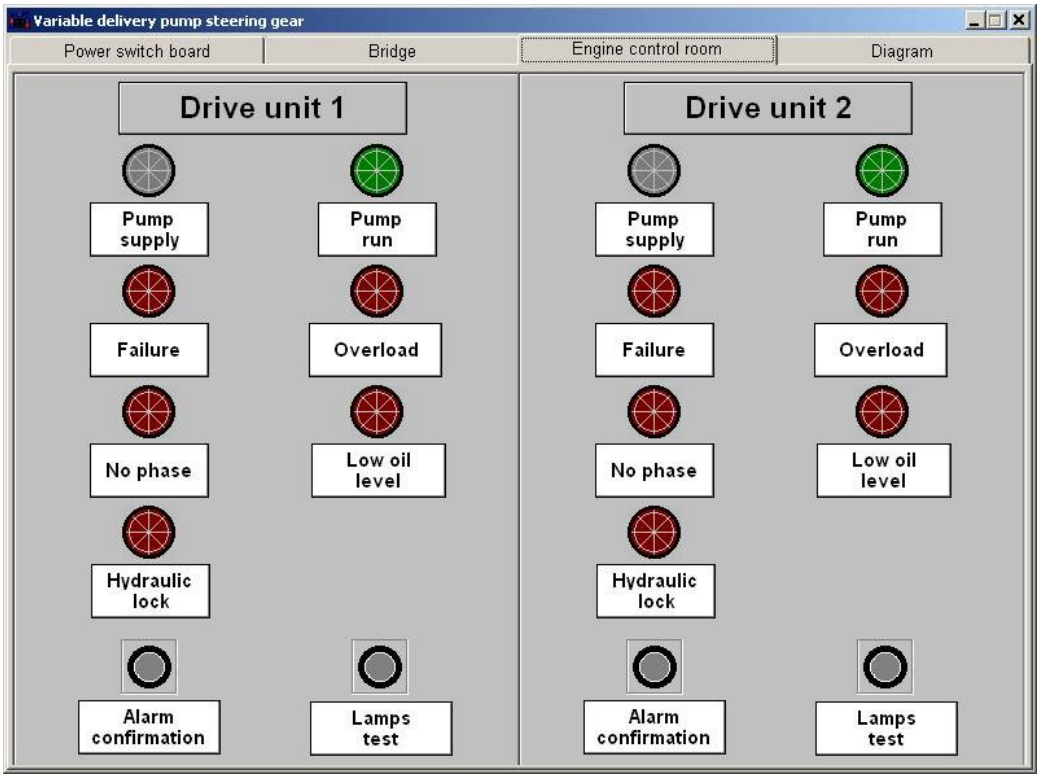

VARIABLE DELIVERY PUMP STEERING GEAR SIMULATOR
FEEDBACK CIRCUIT
RUDDER TILLER EAR
HYDRAULIC NUT

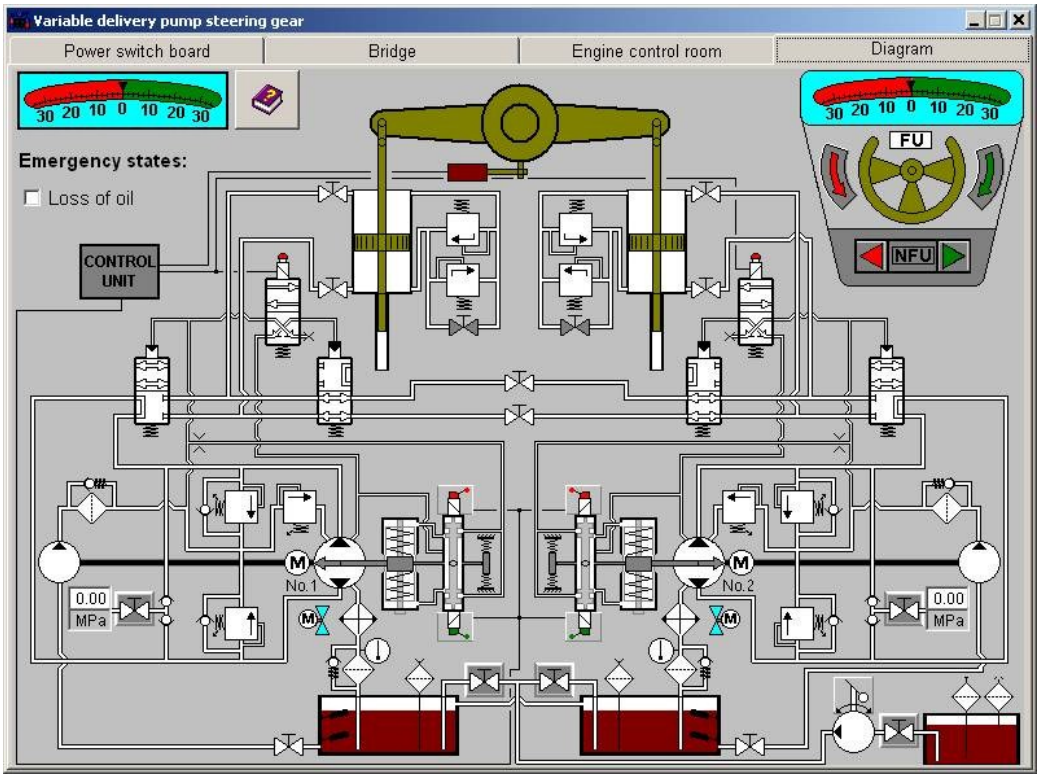
The **simulator program** consists of the following parts:

1) installation diagram
2) power switchboard panel
3) bridge control panel
4) engine control room panel




Variable delivery pump steering gear
Power switch board
Bridge
Engine control room
Diagram
Drive unit 1
Pump supply
Pump run
Failure
Overload
Hyd.circuits separation
No phase
Low oil level
Hydraulic lock
Stand-by
Alarm confirmation
Lamps test
0
I
Remote drive switching
Drive unit 2
Pump supply
Pump run
Failure
Overload
Hyd.circuits separation
No phase
Low oil level
Hydraulic lock
Stand-by
Alarm confirmation
Lamps test
0
I
Remote drive switching


Variable delivery pump steering gear
Power switch board
Bridge
Engine control room
Diagram
Drive unit 1
Pump supply
Pump run
Failure
Overload
No phase
Low oil level
Hydraulic lock
Alarm confirmation
Lamps test
Drive unit 2
Pump supply
Pump run
Failure
Overload
No phase
Low oil level
Hydraulic lock
Alarm confirmation
Lamps test


Variable delivery pump steering gear
Power switch board
Bridge
Engine control room
Diagram
30 20 10 0 10 20 30
Emergency states:
Loss of oil
CONTROL UNIT
FU
NFU
No.1
No.2
0.00 MPa
0.00 MPa